# POWER

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# He Never Had a Chance

"IF I'd had the chance of some fellows I've known, you can bet I wouldn't be doing this kind of work now. I'd be as big as any of 'em."

It was the fireman that was speaking. He was chatting with one of the editors of *Power*, who, while in the country on his vacation, had wandered into a little pumping station and announced himself as "interested in all kinds of machinery."

"I remember one young chap especially," continued the fireman; "I used to kid the life out of him, because he always had his nose in a book. Now he's chief engineer on one of the biggest battleships in the Navy. I think he took one of those correspondence courses. I hear they're pretty good, and that a man can really get an education with them. But as for book-learning and the like, I never had any; my education began with a pick and shovel, and that's about where it left off. Now I'm a fireman. I've a license as assistant engineer, but I don't fool myself into thinking I'm anywhere near to being an engineer on that account. It would have been a different story, though, if I had ever had a chance to get an education.

"Would you like to look around the plant a bit, stranger?"

"Sure thing, I'd be glad to."

So the visitor was shown over the plant, and its apparatus was explained to him, though not very clearly and not with great assurance. Finally the pair stopped before the condenser unit.

"What's this thing?"

"A vacuum pump."

"What does it do?"

"Oh, it runs the whole works, all this machinery. It keeps up a vacuum, and that helps."

"I don't quite understand. What has this vacuum pump to do with that compressor over there, for instance?"

"Well, now, I really couldn't quite explain that so's you would understand. But Jake over there is up on all this technical stuff; he can tell you, and he'll be glad to. Hey, Jake!"

The "vacuum pump" was duly explained, and the editor took his departure. There remained one thing about the plant, however, that he could not understand; and that was, "How can a man work around fairly simple machinery day in and day out and not feel enough interest in it to find out how it works?"

"Correspondence schools!" "Book-learning!" Why, that fireman spends his days in an ideal school. Unstudied lessons are piled about the place. His chief, a kindly man, would be a willing enough instructor. He has leisure enough to build magnificent air castles, but he will not study. He is a perpetual flunk-out in the University of Experience.

Such a man would scarcely be likely to read *Power*, and so these lines cannot be addressed to him directly. They are printed, however, rather in the hope that some kindly and tactful readers may carry this message to those that need it — to such a one, perhaps, as this fireman, who spends his time dreaming of the things he would have bought with the money he would have made — if he had had a chance.

# Repairing Large Alternating-Current Generators—Work on the Core

## How to Make Temporary Repairs to Damaged Cores—Methods of Removing the Coils and Cleaning Armature—Methods of Dismantling and Rebuilding the Stator Core—Tools for Filing the Core Slots

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UNFORTUNATELY, it is sometimes necessary to repair generator armatures in the field. These burnouts are, of course, due to all sorts of causes and may be anywhere from a few coils to the whole winding. Then, too, the core may be more or less damaged. All these factors, as well as local conditions and facilities, have a direct bearing on the best method of handling the repair work.

If the punchings are damaged to any extent it is advisable to take down enough of the core to replace the damaged section. It is sometimes necessary to make temporary repairs when the iron is slightly damaged until such time as the unit can be spared for a thorough job. In these cases all the fused punchings must be removed and the overlapping burs between them removed by filing and scraping. This work must be carefully done, for any contact between the adjacent layers of iron will cause local heating due to eddy currents. The hole can be filled when necessary with a carefully fitted hardwood or fiber block which is held in place by bending over the edges of the adjacent laminations and using the coils and wedges to tie the block securely in place. If a block is advisable, a little thought in trimming out the burned punchings will assist materially in getting a good fit on the block. Iron, brass or in fact any metal will give poor results as a filler owing to the eddy currents set up by the field and armature reactions. Even the smallest blocking should be considered as temporary at best and avoided whenever possible.

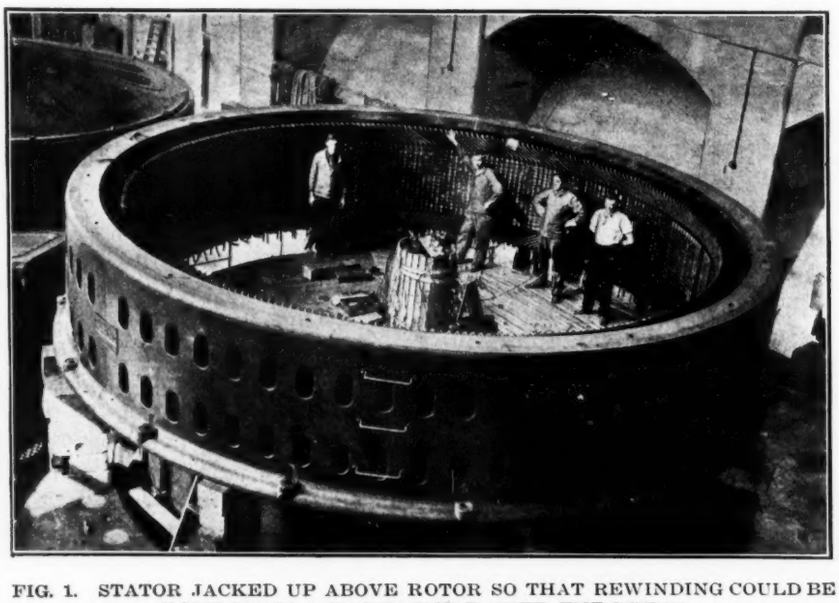


FIG. 1. STATOR JACKED UP ABOVE ROTOR SO THAT REWINDING COULD BE DONE FROM A FLOOR BUILT OVER THE ROTOR

### Large Alternating-Current Generators

This discussion refers to alternating-current generators that are too large to be conveniently sent to the manufacturers or a well-equipped repair shop. The method of dismantling will be determined largely by the design of the machine and whether horizontal or vertical. Consider the horizontal type first, as they are easiest handled.

Practically all horizontal slow-speed machines are so designed that the stationary armature can be slid over on the foundation to clear the field. Examination will then show the amount of repair necessary. In many cases a few coils can be lifted out and the damaged coil or coils repaired or replaced. Great care should be used in bending any of the undamaged coils, especially in an old machine, as the insulation may be brittle from age and heat. If the coils are deep or have a short pitch, it is advisable to heat them before bending. This is especially necessary in cold weather. The heating is best accomplished by putting direct current through the coils that are to be moved. The amount of direct current should be approximately equal to that flowing in the individual coils at full load. This may be considerably less than the full-load current of the machine, depending on the way the windings are connected.

If examination shows the coils beyond repair, they may be removed with a bar, or a crane or any other quick method, as the only salvage is the scrap copper. Bar windings should be handled with more care as the copper can be cleaned, re-formed if necessary and reinsulated. The amount of re-forming can be reduced by a little care in stripping. Coils or bars that are in fair condition should be cleaned thoroughly with gasoline or carbon tetrachloride, dried with a clean dry cloth and given a brush coat of a good air-drying insulating varnish. Better still, one or two coats of insulating varnish can be baked on in the coil-heating oven, which will be described in the next article.

Undamaged portions of the armature are usually full of accumulated oil and dirt which should be completely removed. Scrapers made from worn-out power hacksaw

blades by grinding off the teeth and rifle cleaning rods can be used to advantage. Some solvent will be necessary to cut the grease. Gasoline is the cheapest good solvent available, but is more dangerous than dynamite. The fumes are heavier than air and will pour down into pits or basements and may remain undisturbed for hours till some helper sneaks off for a quiet smoke. A little gasoline can raise a surprising amount of trouble under these circumstances.

Unless the armature is in a direct draft that will sweep all fumes outdoors, an exhaust fan should be arranged to take air from under the armature and discharge outdoors. Stovepipe is cheap, and the end

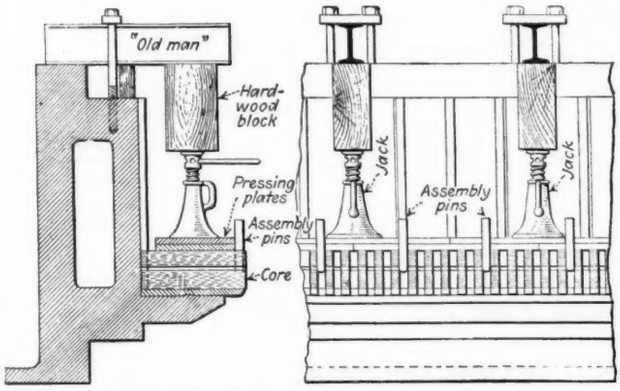



FIG. 2. METHOD OF PRESSING STATOR CORE WITH JACKS DURING ASSEMBLY

can be easily moved to keep the opening under the part of the armature being cleaned. Carbon tetrachloride is not explosive, but is more expensive and cannot always be purchased locally. Pyrene or tetrachloride fire extinguishers and damp sawdust should be kept handy when cleaning with gasoline.

If necessary to remove any great amount of iron, it is advisable to lay large horizontal armatures on their sides to expedite the core work. Cores have been assembled with the armature upright, but it is a costly job when the machine is of any size. Extension blocks bolted to the end flange for lengthening the dovetails are necessary in order to hold the last few layers of punchings before the final press. Several levels of staging are necessary for the men. A large gang is necessary or else the men must do considerable climbing. Then there is always the danger of serious accident from dropped punchings. They are thin and flexible for their weight and usually "scale" or "side slip" when falling, so that they almost always strike edge first. Men have been seriously injured even when they were at some distance from where one would expect a dropped punching to land.

### Repairing Vertical Generators

In preparing vertical generators for repair, four schemes are applicable, depending on the extent of the burnout and the design of the machine:

First: It is sometimes feasible to change a few coils by removing two or three field poles and working in or through the opening thus formed. Bolted poles are easily removed, but keyed poles are more of a problem. The secret of success is to have a drift that fits square against the small end of the taper key and use at least a 10-lb. sledge. One old hand at the game best described the proper procedure by saying, "Get the drift square and snug against the key, and lean on the sledge handle when you hit it." The first blow ought to start the key, for further pounding will upset the end of the key and render removal difficult if not impossible.

Second: If the armature is split, the jump coils can be removed through the opening formed by the removal of the polepieces and the damaged section of the armature moved to a position convenient for work. The joint coils must be handled carefully in opening the split. If they are of short pitch or large cross-section, they should be warmed with current before bending.

Third: Remove the revolving field. This can be done readily where there is a coupling between the generator and the waterwheel and when the crane is large enough to handle the field and shaft safely. A good working platform should be built across the pit to avoid accidents while the men are working on the armature.

Fourth: Many large machines have a one-piece shaft or are designed so that the total revolving weight must be supported by blocking under the field rim when not carried on the thrust bearing. This is the case with the majority of large generators with the thrust bearing above the stationary armature. In several recent repair jobs of this nature the complete armature has been raised high enough to clear the revolving field and supported on blocking. A tight floor was then built on top of the revolving field and this floor used as a winding platform. Fig. 1 shows one of these jobs after the winding was completed. In this particular case an electric oven for heating the coils was placed on the working platform, making a material saving in the time required for rewinding. The taping of the coil connections was done from the station floor. A

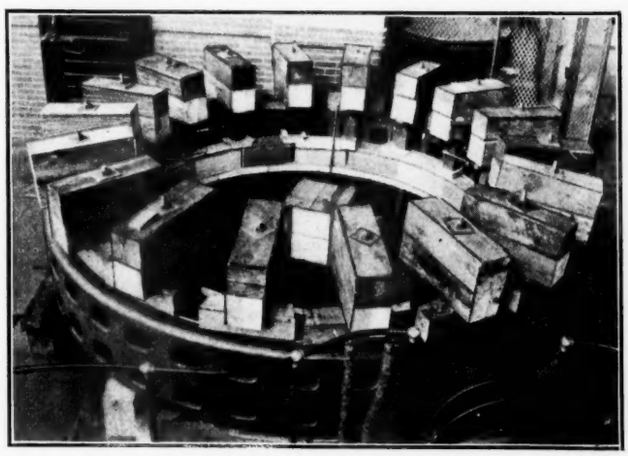


FIG. 3. SAME AS FIG. 2. EXCEPT "OLD MAN" IS MADE OF TIMBER

couple of rough reclining chairs with head rests can be easily constructed from rough lumber and will be a big help in taping on large jobs. It pays to put some thought on conveniences and bodily comfort for the men as more and better work usually results.

### Lifting a Large Armature

It is obvious that great care must be used in lifting a large armature in this manner. Slings should be carefully inspected for any defects and well padded where they come across corners to prevent cutting. Ample blocking should be provided and arranged to

follow the armature closely as it is hoisted. The majority of the blocks can be placed radially; that is, across the armature base. This arrangement will prevent the armature slipping sideways, but there is a chance that it might rotate and some of the blocking should, therefore, be skewed to prevent this. It is advisable to use too much blocking rather than too little and when in doubt always err on the safe side. The best plan is to have the blocking arranged with various thicknesses to follow the armature within 2 or 4 in. Then, if anything lets go, no great damage will be done.

If it is necessary to remove lamination, a lot of good iron usually must be taken out to get at the damaged section. A great deal of care should be used to prevent bending or kinking the good iron. This iron must be examined carefully, straightened if necessary, and any burs on the edges removed by light hammering before it can be used again. The burs on the edges of the slots may be considerable due to the broaching and filing when first installed. If the burs or kinks are not removed, the front of the core will build up faster than the back, and it will be impossible to get a tight core.

### Rebuilding the Core

The first step in rebuilding the core is securing "assembly pins." These "pins" can be made of two pieces of cold-rolled key stock, 8 in. to 12 in. long and a little less than half the width of the slot in thickness. The width may be anything from $\frac{3}{4}$ in. to the whole depth of the slot, although $\frac{3}{4}$ in. to 1 in. will give good results in all cases. Thin shims of metal or even paper are placed between the two pieces till the combined thickness is just that of the slot. These keys or "pins" are placed in the slots so that they extend

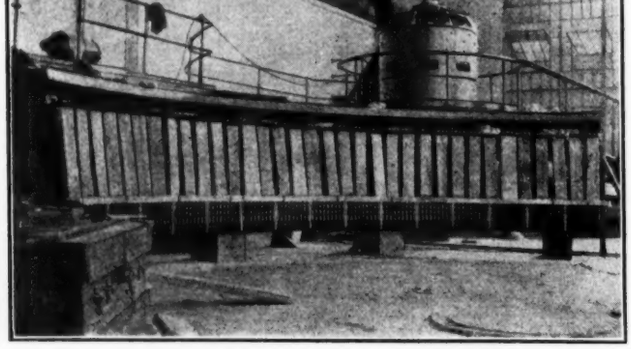


FIG. 4. PRESSING STATOR CORE DURING ASSEMBLY BY USING PIECES OF PLANK

about one-third their length above the laid core surface. There should be two keys for every length of punching.

There is a little leeway in the slots and dovetails and these pins throw the variation to the dovetails and bring the slots to proper size. This saves a lot of hard work in broaching and filing the slots. The keys are moved, of course, as the core assembly progresses.

The second step is providing some method of pressing the core as the assembly progresses. This pressing must be carefully done to get a tight core. "Early and often" is a good motto in this work. Judgment in the amount of pressure applied must be used. You want a tight core, but too much pressure may bend the end fingers, especially when only a small amount of iron has been put in place.

Probably the best equipment in the way of jacks is shown in Fig. 2. This scheme permits of stacking iron without removing the "old man." The jacks are the standard house-movers screw-jacks with $1\frac{1}{4}$-in. screws and 6 or 8 in. high, and can be obtained from almost any hardware dealers. The blocks under the jacks can be sawed off as the core building progresses. The "old man" can be made of short sections of I-beams, as shown in Fig. 2, or of timber, as shown in Fig. 3. The pressing plates on the core can be of steel or of hardwood. If there are several cores to build, steel plates are preferable, but the average single core can be handled with wooden blocking picked up on the job. Care should be used to get the proper number of laminations in each section so that the air ducts will register with the openings in the rotor, or poor air circulation and consequent heating will result. The last section can be pressed with the end plates themselves, or the jack may be placed on the top of the end plates and pressure applied while the end-plate bolts are tightened provided, of course, there is enough clearance under the "old man."

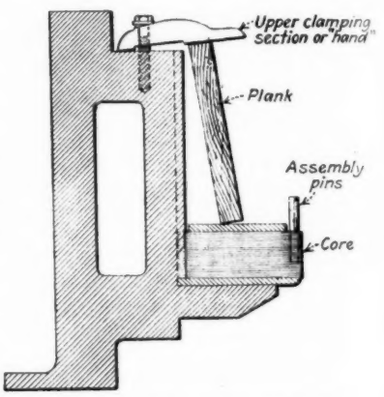


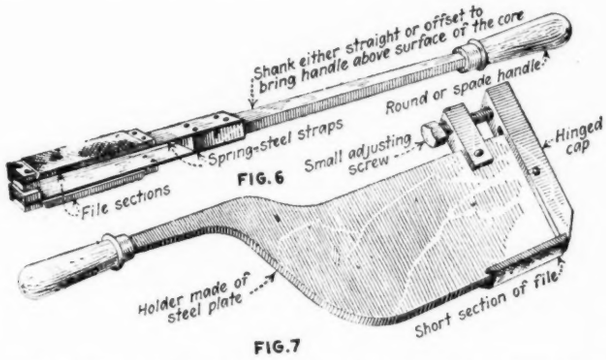

FIG. 5. DIAGRAM OF PRESSING METHOD USED IN FIG. 4

Fig. 4 shows a different arrangement that was used in an emergency, where jacks could not be obtained. In Fig. 4 pieces of plank were cut a little longer than the distance between the top of the punchings and the top of the frame and then stood on end as shown in the picture. The upper end of each plank comes under the end of the clamping section or "hand" that is furnished to hold the upper end of the core. The plank is a little bit long so that there is from a quarter to one-half inch take-up when the bolts holding the "hands" are tightened. The planks are tipped in at the top to get as close to the bolt as possible and to lessen the strain on the "hand" or end clamping sections. Of course, the planks have to be sawed off for each press, and the final press is made by bolting the sections directly down against the punchings. This arrangement is also shown in the diagram, Fig. 5.

### Broaching and Filing the Slots

The next step is broaching and filing. The broaching consists of driving a steel block of the exact cross-section of the slot through the slots. A second broach of the exact size of the wedge is driven through the dovetail at the top of the slots. The slots are then filed, bottom, sides and dovetails. This filing is best done by short filing strips held in a spring file holder. Fig. 6 gives an idea of what the spring file holders are like. These are sometimes made with a straight shank and a round wooden handle, and sometimes on long

cores the shank is offset and a spade handle put on to avoid the necessity of making the shank as long as the slots, which in some cases are several feet. The file sections are special and the ends are ground at an angle so that they will drive in to the dovetails on the side of the spring holder. These spring holders are given a slight set so that they will tend to separate. On the forward stroke these springs bring the files out against the sides of the slots so that the files will take hold.




FIGS. 6 AND 7. TOOLS FOR FILING SLOTS IN STATOR CORE

On the return stroke the springs close up so that the files can be drawn back readily. These holders can also be used for holding the dovetail files. The bottom file holder, as shown in Fig. 7, is usually made up of a piece of quarter-inch steel plate. A hinged cap is fitted over the end of the holder and a pin put through. A small block is straddled over the top of the plate and provided with a tap hold and setscrew to bear against the hinged cap. The bottom of the plate has a notch about 6 in. from the end, so that a section of rectangular file of the proper width can be clamped between this notch and the hinge cap by means of the adjusting screw on the upper side. The adjusting cap-screw, end cap and notch for the file are about the same on all holders. The shape of the body of the holders and the handles may vary according to the fancy of the toolmaker. The main idea, of course, is to get the handle above the surface of the particular core.

The amount of filing and broaching is in inverse ratio to the care used in getting the assembly pins of the proper size and evenly distributed as outlined earlier in this article. The slots must be without any high punchings or burs. Any bridging of punchings by burs will lead to overheating of the core.

[*A second article will deal with the rewinding of the machine and putting it back into service.—Editor.*]

## A New Combustion Process

Attempts to burn solid fuel in suspension without prepowdering have, up to the present, been confined to utilizing the air for suspension purposes, but obviously only fine screenings and no lump coal can be held in suspension by this means, and the process fulfills only one part of the stated requirements, since enough air must be used to accomplish the suspension necessary for complete mixture without regard to minimum excess air demanded for perfect combustion. In other words, to maintain the most efficient combustion conditions, air for suspension and air for combustion must be either governed by the latter or the two factors completely divorced.

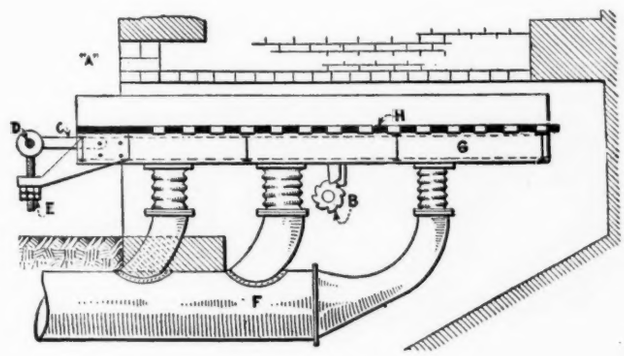
A new process of combustion has been evolved which is intended to accomplish the suspension by simple mechanical means, at the same time causing the fuel to be moved into the furnace toward the ash offtake, powdering the fuel more or less during the process, by bouncing it on the grate.

The fuel is fed at end *A* of the grate by gravity in any standard manner. The motion of the grate is imparted by the cam *B*, upon which it rests while the links *C* and shaft *D* prevent longitudinal motion, and eye-bolts *E* supply the means of regulating the angular inclination of the grate. Air is supplied from the main blast line *F* through flexible connection to the air-box *G* upon which is mounted a movable shutter free to slide for the purpose of increasing or decreasing the air vents which are narrow and well distributed over the entire shutter surface. The sides of the air box are water-cooled, and the whole apparatus is entirely free and independent of the furnace brickwork.

The motion of the grate keeps the fuel bed in a constant state of suspension or semi-suspension during the process of combustion. The rate of combustion is controlled by varying the speed of the cam, by the angular inclination; the height of the feed-door above the grate, and the pressure and volume of air.

Because the fuel bed is in the state of suspension, it is claimed by the inventor that fuel ash cannot accumulate in the form of clinker nor can air holes form, and therefore, a clean, level, homogeneous and porous fire, of any desired thickness, is maintained at all times, insuring a perfect air distribution and other conditions appropriate for perfect combustion.

The entire bed of fuel is raised by the grate, which is suddenly dropped so that the fuel falls to the grate surface by gravity and then rebounds from the rising grate, and rapid repetitions of this action keep the solid fuel in a state of suspension or semi-suspension above




AGITATING GRATE

the grate through which it does not pass by reason of the air pressure in the air box and the construction of the grate.

The vibrations cause the fuel bed to move forward along the grate from the feed end in front to the offtake in the rear, over which the ash passes partly in loose form and partly in the form of fused shot and pebbles.

Preliminary trials have been conducted by the inventor, C. H. Ridderstedt, in Pittsburgh, Pa., on an experimental unit of this type under a water-tube boiler using bituminous coal, and plans are now under way for further experiments with anthracite culm and coke braize, after which it is intended to build a stoker for actual commercial operation.

# Louisville's Mammoth Pumping Engine

*Vertical triple-expansion, condensing, crank-and-flywheel pumping engine with capacity of 30,000-000 gal. in 24 hr. and a total weight of 2,450,000,-lb. The unit is self-contained, has a water end of 99 in. diameter, mechanical efficiency of 96.5 per cent and a steam consumption per water horsepower per hour of 10.45 lb.*

THE 30,000,000-gal. vertical triple-expansion pumping engine installed recently at the new Ohio River station of the Louisville Water Co. is an example of the latest development in this class of machinery. It is designed specially to take care of the extreme variations in level (about 70 ft.) of the Ohio River at this point, as well as the dirt, silt and débris contained at times in this water. Owing to these conditions the unit has a water end exceptionally deep and a valve chamber with a record diameter of 99 in. The unit, which was built by the Allis-Chalmers Manufacturing Co., is self-contained. The operating conditions and principal dimensions are given in Table I. The water end of the unit is installed in a pit that is 49 ft. deep below the engine-room floor (see illustration). There are three sets of pump chambers with two valve decks each arranged on soleplates, each set being vertically underneath its corresponding steam cylinder. These chambers consist of a suction chamber of cast iron over which is a cast-steel valve deck, a valve chamber of cast steel over which is a cast-steel discharge-valve deck, and the discharge chamber which contains a large cushioning air space and supports one end of its corresponding engine bedplate. The discharge chambers are braced to the concrete pier by cast-iron braces built into the concrete, which also carry the plunger guides. The final member of the set is the barrel in which the plunger travels. This is supported on a heavy casing vertically below the center of its corresponding steam cylinder and is connected to the valve chamber by a heavy flanged nozzle.

### Details of Parts

The other end of each engine bedplate rests on the concrete pier. Each engine bedplate is reinforced by the addition of a heavy strut column extending from a point directly below the center of the shaft and resting on the air-chamber braces. The three bedplates carry 20-in. crankshafts and two 20-ft. flywheels, each weighing 37.5 tons. The work is almost equally distributed by the steam cylinders, so that the function of the crankshafts and flywheels is for the most part to maintain the relative position of the cranks and to equalize the effort of the steam cylinders on the plungers.

The steam cylinders, which are 32, 60 and 96 by 66 in., are supported by massive double A-frames resting on the corresponding bedplate, each frame being braced to the adjoining one. The crosshead guides are cast into these A-frames.

From eccentrics carried on a layshaft on the first gallery the valve gear is operated. The layshaft is driven from the crankshaft by a set of machine-cut spiral gears, running in oil, through a vertical drive shaft. There are separate eccentrics for each set of steam and exhaust valves.

Corliss valves with long-range cutoff are used on the high-pressure cylinder and for the steam valves on the intermediate cylinder. The exhaust valves of the intermediate and all the valves on the low-pressure cylinder are of the single-beat poppet type. All valves are located in the cylinder head and arranged to give ports of ample area and a minimum of clearance volume. The high-pressure cutoff is controlled by a centrifugal regulator arranged for hand adjustment of speed and also with an automatic vacuum breaker to relieve the vacuum in case of overspeed due to the breakage of a main. The intermediate cutoff is adjustable by hand, while the low-pressure cutoff is fixed.

### Cylinders are Steam Jacketed

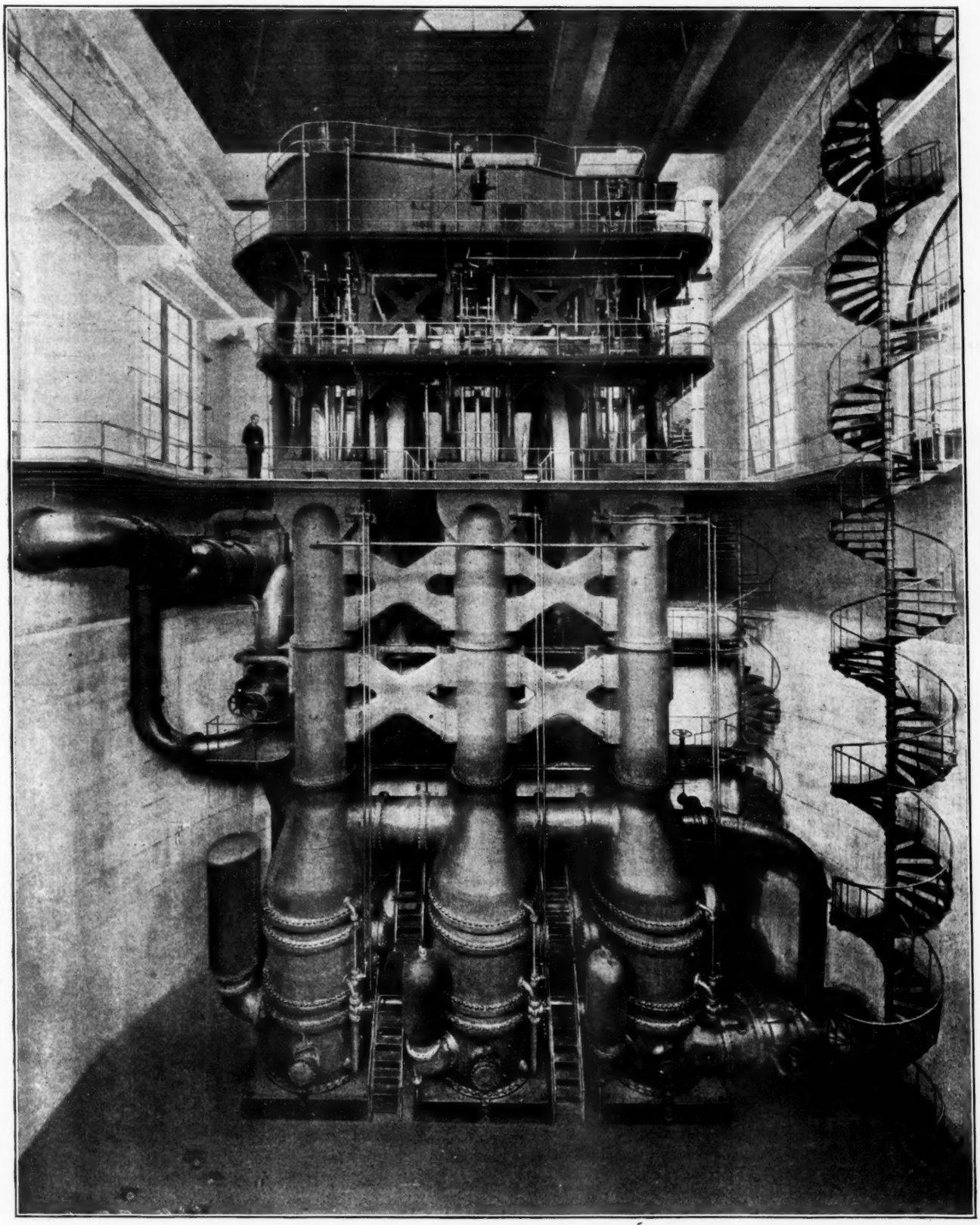
All cylinders are surrounded by jackets each supplied with steam at the maximum pressure of that of its cylinder. Steam traps receive the condensation from the jackets and discharge it into the hotwell. Receivers of large capacity are located between the cylinders. No reheating coils are used in these receivers, as with this type of engine they are considered a detriment to economy.

Each steam piston is connected to its pump plunger by four steel distance rods, which are carried on lugs on the cast-steel engine crosshead. These rods extend downward to an extension of the plunger head, made necessary by the great depth of the pump pit. Both the distance rods and the plunger-head extension are provided with guide bearings to insure alignment and prevent vibration. This arrangement provides for the direct application of the power from steam to water, leaving only the excess power at different points of the stroke to be transmitted to and from the flywheel through the connecting rods and crankshaft. The weight of the reciprocating parts is adjusted so that the work of pumping is equally divided between the up and down strokes, although the plunger is single-acting. Each plunger is 38 in. in diameter and has a stroke of 66 in.

### Arrangement of Condenser

Exhaust steam from the low-pressure cylinder is condensed in a surface condenser of the single-pass type located in the discharge main. The entire pumpage flows through the tubes of the condenser, large areas being provided to minimize friction losses. The vacuum is maintained by a single-acting air pump attached to the low-pressure plunger extension. A single-stage air compressor is attached to the intermediate plunger extension, its chief function being to furnish air for the discharge air chambers and to supply the air-operated balance pots on the poppet-valve gear. There is also attached to the intermediate-plunger extension a single-acting boiler-feed pump which takes the condensate from the hotwell and forces it through an oil separator and two feed-water heaters of the closed type. It is thus evident that the unit is self-contained, the auxiliary work being accomplished at the economy of the main steam cylinders. Hot water from the jacket and receiver drains is piped from the traps to the hotwell to conserve the relatively large amounts of heat contained therein.

The water ends of the pump are proportioned and arranged to provide low velocities of the water and



THIS TRIPLE-EXPANSION CONDENSING PUMPING ENGINE, WEIGHING 1,225 TONS, HAS A CAPACITY OF 30,000,000 GAL. IN 24 HOURS. THE STEAM CYLINDERS ARE 32, 60 AND 96 BY 66 IN. AND THE WATER CYLINDERS ARE 38 BY 66 IN. THE VALVE CHAMBER ON THE WATER END IS 99 IN. IN DIAMETER

freedom from abrupt reversals due to the action of the plungers. The various chambers are interconnected by flanged nozzles and a large equalizing pipe connects the air-cushioning space in each discharge air chamber, thus making all three chambers effective in cushioning the discharge of each plunger. As a further means of providing easy flow a large air bottle is attached to each suction chamber. The starting up of the unit and its manipulation while not in operation are facilitated by the use of lever valves opening into the valve chamber, from the suction and discharge chambers, allowing the full discharge pressure to be applied beneath the plungers.

This unit pumps the raw water from the Ohio River to the settling reservoir, after leaving which the water

TABLE I. OPERATING CONDITIONS AND PRINCIPAL DIMENSIONS OF LOUISVILLE PUMPING ENGINE

| | |
|---|---|
| Capacity, gal. in 24 hr | 30,000,000 |
| Total head pumped against, ft | 200 |
| Steam pressure, lb. gage | 160 |
| Superheat, deg. F | 80 |
| Vacuum at exhaust nozzle, in. of hg | 27 |
| Guaranteed duty, work done per million B.t.u. furnished engine, reckoned from temp. of boiler-feed water, ft.-lb | 160,000,000 |
| Steam per water horsepower, lb | 10.45 |
| Weight of unit, lb | 2,450,000 |
| Height from sole plates to top of valve gear, ft | 80 |
| Steam-cylinder dimensions, in | 32, 60 and 96 by 66 |
| Water plungers, single-acting, dimensions, in | 38 by 66 |
| Valve chamber water end, diam., in | 99 |
| Flywheels, two of 20-ft. diam., weight of each, tons | 37.5 |

TABLE II. SUMMARY OF OFFICIAL TEST DATA

| | |
|---|---|
| Duration, hours | 8 |
| Pressures: | |
| Barometer, lb. abs | 14.46 |
| Steam at throttle, lb. gage | 161.5 |
| Vacuum referred to 30 in. bar., in hg | 28.36 |
| Net head pumped against, including suction lift, ft | 200.04 |
| Temperatures: | |
| Steam at throttle, deg. F | 450.4 |
| Apparent superheat, deg. F | 79.1 |
| Condensate entering exhaust heater, deg. F | 80.2 |
| Condensate leaving exhaust heater, deg. F | 91.2 |
| Condensate leaving second receiver heater, deg. F | 198.1 |
| Capacities: | |
| Average r.p.m. during 12 hours | 21.771 |
| Rate of pumpage "displacement," gal. per 24 hr | 30,475,336 |
| Rate of pumpage, rise of reservoir, gal. per 24 hr | 30,260,000 |
| Rate of pumpage, venturi meter, gal. per 24 hr | 30,780,000 |
| Horsepower and mechanical efficiency: | |
| Average water hp. from test data | 1,071 |
| Average mechanical efficiency from indicator cards, per cent | 96.5 |
| Average indicated hp | 1,110 |
| Steam used: | |
| Steam used per indicated hp.-hr | 10.09 |
| Steam used per water hp.-hr | 10.45 |
| B.t.u. per indicated hp. per min | 182.2 |
| Thermal efficiency of engine referred to indicated hp., per cent | 23.27 |
| Duty: | |
| Foot-pound work done per 1,000 lb. steam used | 189,324,000 |
| Foot-pound work per million B.t.u. under test conditions | 174,667,000 |
| Foot-pound work guaranteed under standard conditions, per million B.t.u. | 160,000,000 |

is filtered and pumped to the city mains. It contains a great deal of sand and mud at times, which has a serious effect on the ordinary type of flat rubber pump valves. To overcome this erosive action, flat valve decks of the unusual diameter of 99 in. are provided, which permit the use of beveled rubber valves, lifting vertically. These valves are arranged on the valve decks instead of on separate valve cages, and small cast-iron weights, instead of coiled springs, are used to insure proper seating.

Location of the condenser in the discharge line with provision for reversal of flow to clear the tubes of accumulated sediment, is an unusual arrangement. A separate connection for reversing the flow through the intake to clear it of needle ice in winter is also provided.

Where the conditions of the service are favorable, it can be shown that the thermal efficiency of an installation can be increased by the use of steam taken from the working charge of an engine at various points to heat the boiler-feed water. In this case two closed-type heaters are used. The first is located in a bypass on the exhaust pipe from the low-pressure cylinder. The feed water is next passed through a heater which uses steam from the low-pressure receiver, and in this heater the temperature is raised to somewhere near the boiling point. The result of this arrangement from the standpoint of the heat balance of the plant is a departure from the standard Rankine cycle, in that the heat rejected is returned to the system at a temperature higher than that corresponding to the back pressure at exhaust. The effect of the change will be seen in the summary of the official duty trial given in Table II.

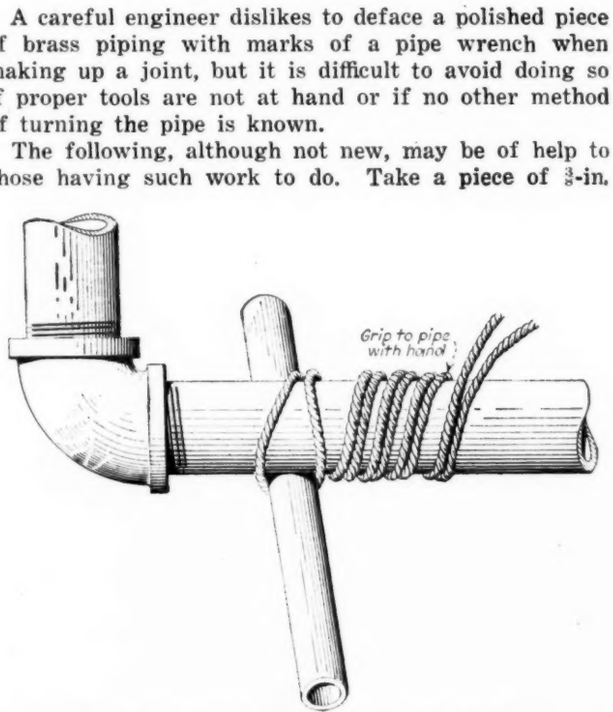
These data serve to indicate the high economy that is attained by a unit of this type, and in particular at the pressure and superheat given. One of the strong features of such an installation is the flat efficiency curve produced over a great range of conditions as to discharge-water pressure and at various speeds. This is particularly noticeable where, as is coming to be the case in many cities, the water is pumped directly into the city mains without the use of a storage reservoir. In this service the great variation in demand must be taken care of by operating the pump at various speeds to maintain the required discharge pressure. The economy does not stop with the engine room, but is reflected in smaller boiler and coal-handling equipment and less coal-storage space.

## An Emergency Pipe Wrench

BY E. P. RODNEY

A careful engineer dislikes to deface a polished piece of brass piping with marks of a pipe wrench when making up a joint, but it is difficult to avoid doing so if proper tools are not at hand or if no other method of turning the pipe is known.

The following, although not new, may be of help to those having such work to do. Take a piece of ⅜-in.




HOW THE CORD IS APPLIED TO THE PIPE

cord, or larger, depending on the size of the pipe, double it, allow the looped end to extend sufficiently beyond the pipe to insert a bar, as shown in the illustration, and wind the double strands about the pipe four or five turns. Then, holding the loose ends with one hand and exerting a pull on the lever, the most stubborn joint may be broken, and when the cord is placed on the pipe in a reverse position, a tight joint may be made up without danger of scarring or crushing the pipe as is likely to happen when using a pipe wrench.

# Effect of Tube Location on Strength of Drum*

IN FIG. 1 is shown the arrangement of tube holes for a boiler drum as originally selected by the designer in the case under consideration. Later he wished to change over to the arrangement shown in Fig. 2, believing that this could be done without reducing the strength of the plate, since the distance between holes

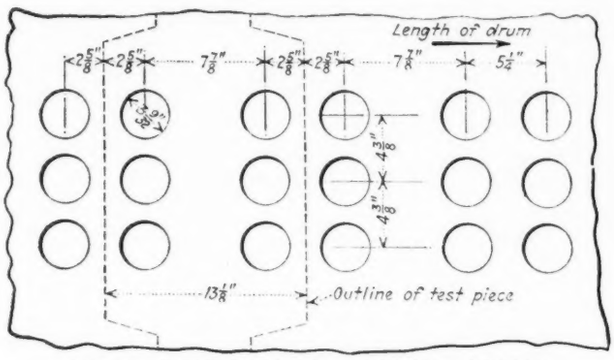



FIG. 1. TUBE HOLES IN ORIGINAL DESIGN

in the same horizontal line would be the same in both cases. To settle the question, some tests were made which showed that the second arrangement of holes was decidedly weaker than the first arrangement.

Four test pieces were prepared, one as shown in dotted lines on Fig. 1, two as shown in dotted lines on Fig. 2, and one of undrilled stock but otherwise the same as the first three. All the test pieces were cut with the grain of the metal and carefully machined to a thickness of ¼ in. and a width of 13¼ in. By means of a 300,000-lb. Olsen testing machine the elastic limit and ultimate strength of each piece were determined. It was then possible to express the strength of the drilled plates as a percentage of that of the undrilled plate or, in other words, to determine the efficiencies of the two methods of drilling. Fig. 3 shows the four pieces after testing. Distortion is indicated by the white lines which were originally straight. The letters *A*, *B*, *C* and *D* show the order in which the ligaments broke. Test pieces 1 and 2 correspond with Fig. 2 and test piece 3 with Fig. 1. The table shows the results obtained from these tests:

| Test No. | Drilling | Elastic Limit, Lb. per Sq.In. of Gross Cross Section | Ultimate Strength, Lb. per Sq.In. of Gross Cross-Section | Per Cent Efficiency of Drilled Plates Based on Elastic Limit | Per Cent Efficiency of Drilled Plates Based on Ultimate Strength |
|---|---|---|---|---|---|
| 1 | Diagonal | 12,500 | 27,300 | 44.8 | 45.1 |
| 2 | Diagonal | 11,100 | 27,900 | 39.8 | 46.1 |
| Avg. 1 and 2 | Diagonal | 11,800 | 27,600 | 42.3 | 45.6 |
| 3 | Straight | 15,700 | 30,500 | 56.2 | 50.4 |
| 4 | Solid | 27,900 | 60,500 | 100.0 | 100.0 |

The tests prove that the arrangement of holes shown in Fig. 1 gives a considerably higher efficiency than the diagonal arrangement shown in Fig. 2. On the elastic-limit basis the two diagonally drilled pieces showed an

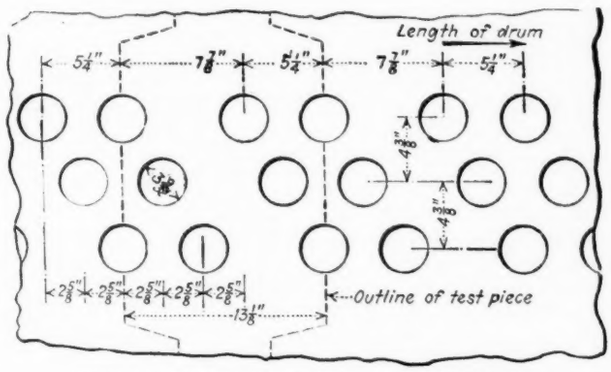



FIG. 2. SUGGESTED NEW ARRANGEMENT

average efficiency of 42.3 per cent, while the straight drilling gave 56.2 per cent. The idea that the diagonal drilling would show the same strength as the other was based on the erroneous assumption that in the former case, as in the latter, the fracture would take place along a line of holes perpendicular to the pull.

Since only two pieces were tested with the diagonal drilling and one with the perpendicular drilling, too much dependence should not be placed on the exact relative values of the results obtained.

*Data and information supplied by J. C. McCabe Chief Inspector, Board of Boiler Rules, Lansing, Mich.

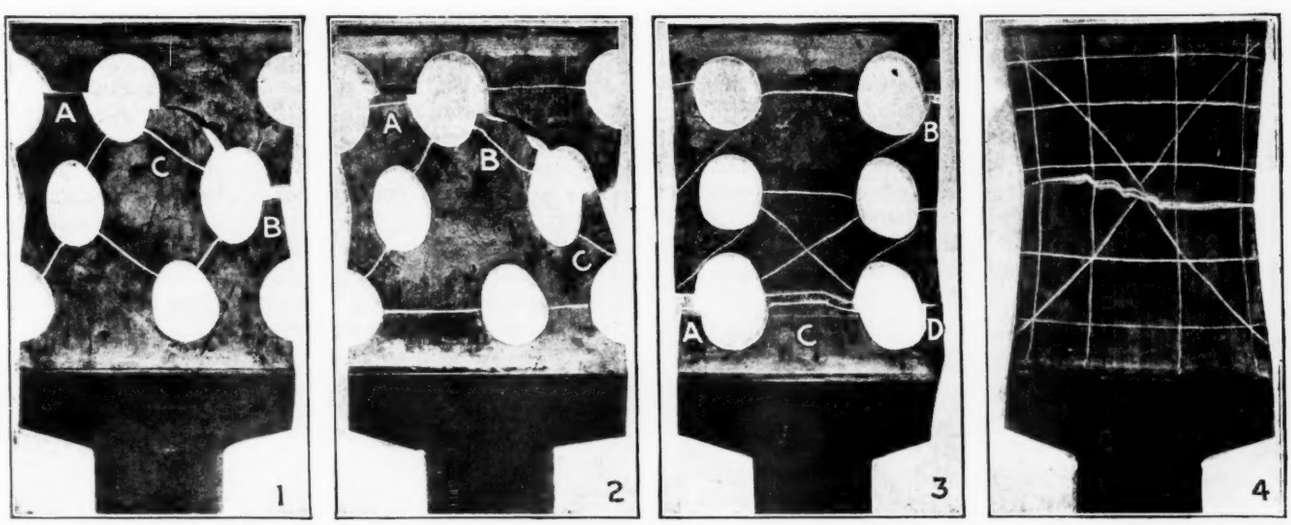



FIG. 3. TENSILE TEST PIECES FOR COMPARING THE EFFICIENCY OF THE TWO ARRANGEMENTS

# Power-Plant Accounts—I. What Is Accounting?

By WILFRED E. MILLER

THE cost of generating power in the isolated plant is steadily becoming of greater importance. A system that provides for the determination of costs is of two-fold value. In the first place it supplies a means of comparing the cost with that which may be submitted by a public-service corporation, and in the second place, if the system be carefully laid out, it permits of such an analysis of the cost as will indicate where economies can be effected. Although, to the uninitiated, the bookkeeping involved in keeping track of costs may appear to be a complicated affair, in reality it will be found to be a simple matter of keeping records. All of us are to a greater or less extent doing bookkeeping all the time. When we make a memorandum in a notebook, we are keeping books, because we are recording some fact. That is all that bookkeeping really is—the recording of facts.

In order to get at the cost of the power that we are generating, we simply make a record of all the items that enter into the cost and keep them together for a month or a year. At the end of that time the sum of all the items gives the total cost. All that is needed to start with is a blankbook and a pencil. If you are interested in starting a cost record for your plant, it is suggested that you buy a cheap blankbook and rule off a few pages as illustrated in Fig. 1.[1] For the present pencil entries will do, and they can be corrected more readily than entries made in ink. In this book make memoranda every day of all the items of cost that come under your observation in that day. They may include one or more of those that are given in the list of Items of Cost herewith.

Items of Cost: Labor (wages), fuel, water, lubricants, ash removal, repairs, scale removed, miscellaneous supplies, investment.

In the column headed "Date" enter the month and day, and under "Class" give the kinds of the items for that day, such as lubricants, miscellaneous supplies, etc., as the case may be. In the column headed "Description" give details. For example, when we receive a barrel of cylinder oil and a bale of cotton waste, the entries would be:

| Class | Description |
|---|---|
| Lubricants | 1 bbl. cylinder oil |
| Miscellaneous supplies | 1 bale cotton waste |

If the value of an item is known, write it in the "Amount" column, otherwise leave it blank for the time being.

In order to make clearer just what the various entries should contain they will now be taken up one by one and given individual attention.

Labor—By labor is meant the wages paid to employees in the power plant. Since wages are paid once a week or once or twice a month, according to the custom of the concern, it will not be necessary to make a daily entry for this item; merely make one on each payday. If some are weekly and others are monthly salaries, enter the former once a week and the latter once a month.

The labor is used for a number of things. Some of it is employed in making steam and some of it in generating power, these being the most prominent uses. In addition we should expect to have some labor devoted to ash removal, repairs, scale removal, and the like. There will also be some labor that cannot be said to belong to any one operation, as for example the time of the chief, which is spread all over the plant. Later we will try to keep a separate record of all these different kinds of labor, but for the present it will be sufficient to keep track of all the labor together without attempting to divide it up.

Fuel—By fuel we mean, of course, the coal or fuel oil burned under the boilers to make steam. Since the majority of plants are coal-fired, it will be assumed that we are dealing with that type of firing. The principles being developed here are applicable equally well to either type, and it will therefore be just as well to reserve any discussion of differences in the details until we get further along.

Ordinarily, the weight of coal burned should be entered each day in the blankbook. Whether it is possible or not to do so depends, of course, chiefly on the manner in which the coal is handled. If it is shoveled directly from the main pile into the furnaces, it may be impossible to determine with any degree of accuracy how much has been fired during a day. In that case we can make an entry in our book each time that coal is delivered to the pile. This entry would be made on the day the coal is received and would give the weight, which must be determined from the delivery slip or from some other source. Of course that would not tell us how much had been used each day, but at the end of the month we could add together all the deliveries and say that this was the amount of coal used in the month. Such an assumption might not be strictly true, but it would serve in place of a more accurate method. When coal is conveyed in small lots from storage, as by barrow or chute, some means should be provided—if they do not already exist—of getting the weights of the lots as they come in and chalking them up somewhere one under another. At the end of the day they should all be

This is the first of a series of articles written in conversational style and treating the subject of power-plant accounts in a thorough, yet simple manner. They were prepared primarily for the guidance of the operating engineer who wishes to keep track of the cost of the power he is making, but who knows nothing at all about bookkeeping. Others may find the articles helpful in clearing up their ideas on the subject. This installment tells what accounting is and shows how to keep records of the following items of expense: Labor, fuel, water, lubricants, ash removal, repairs, scale removal and miscellaneous supplies.

[1] The third article in this series will describe a more convenient form for recording this information. Therefore, the reader is not advised to start a permanent record book at this point, but rather to experiment with a cheap blankbook to get the idea.

added together and the total amount entered in our blankbook. It will prove useful in doing this to rule up a slip of paper each day, somewhat in the manner illustrated in Fig. 2, and tack it up on a board in a convenient place for entries to be made on it. If it is found impracticable to weigh each lot it is possible to get around the difficulty by weighing a single lot and assuming this to be a standard weight. Then it is only

| | DATE | CLASS | DESCRIPTION | AMOUNT DOLLARS | AMOUNT CENTS |
|---|---|---|---|---|---|
| | | | | | |

FIG. 1. PAGE OF JOURNAL (SIMPLE FORM)

necessary to keep track of the number of lots in a day and multiply this number by the standard weight per lot to get our weight for the day. This method, naturally, is not nearly so accurate as weighing each lot, but we may adopt it if there is no better way.

Some of us might object to saying that the coal received in a day had been burned during the day, because, as a matter of fact, perhaps it was not all fired. However, what is left one day will be used the next, and in the course of a month we would have a very accurate total in spite of slight daily discrepancies. As we go along we shall find that the expenses of one month are generally compared with those of other months, and hence the really important thing we are after at present is to get our monthly totals correct, irrespective of whether they are obtained daily or not.

When we keep track of individual lots of coal conveyed to the boiler room each day, we do not have to pay any particular attention to the coal that is delivered to the main storage. What we might do is to size up the quantity on hand at the beginning of a month and find out how much was received during the month, then add the two together to find out how much we would have had on hand if we had not used any. Subtracting what we did use will give what ought to be left at the end of the month. If we inspect the quantity in storage at the end of the month, we may find it very evident that it is less or greater than what ought to be there. In that case the indication is that something is wrong with our system of keeping track of weights, and the matter must be investigated and corrected.

Water—If water is bought from a water company, or town or city, at a certain price per cubic foot or gallon, we shall have no difficulty in arriving at its cost provided the water used by the boilers is metered separately from that used elsewhere. When only one meter serves the entire premises, the best that can be done is to estimate what part of the total water metered has gone to the power plant. This may be a large or a small proportion, depending upon what the water is used for in the various departments. It will be sufficient to take meter readings at the end of each month to get the consumption for the entire month, so that only one entry per month need be made for water.

If the water is obtained from our own well or some other similar source, it will not be necessary to consider its cost. It is true that the power used for pumping plus other items should be charged against the water used, but we are not as yet prepared to consider the subject so critically.

When we refer to the cost of water it is, of course, understood that we mean the water used in the boiler and engine rooms of a fuel-burning plant. In a hydraulic plant the cost of water is naturally looked at from a different point of view. The costs in a hydraulic installation will receive attention later; for the present we shall confine ourselves to the plant using coal as its original source of power.

Lubricants—These may be of different kinds, such as cylinder oil, machinery oil, grease, etc. It is not feasible to make an entry each day of the amount used that day. Usually, it should be found sufficiently accurate to make an entry every time that a barrel or can

COAL USED

| | From | To |
|---|---|---|
| Date | | |
| Time | A.M. P.M. | A.M. P.M. |

| LOT No. | WEIGHT LBS. | LOT No. | WEIGHT LBS. |
|---|---|---|---|
| | | | |

FIG. 2. SHEET FOR KEEPING TALLY OF COAL USED

of any kind of lubricant is opened and assume that the total of such entries is the cost of lubricants used during the month. While it is true that not all the lubricants thus entered during a month might be used up by the end of the month, the item is such a small one as to make it inexpedient to get it more closely.

Ash Removal—When ash removal is contracted for with some outside party, it is merely necessary to take the monthly bills rendered by the contractor in order to get the cost for the month. Whether he renders his

bill promptly on the last day of the month or not, we must make an entry in our book on that day. If the bill is not available, the amount is left blank. Should we handle our own ash removal, we will make no entry for it, unless we have to pay for dumping privileges, in which case this item would appear monthly. In some localities ash can be sold, and when such is the case, entries would be made of the amounts owing us, but we would distinguish them from other entries by drawing a line completely around them or by entering them with a red pencil.

It will be noted that the labor incidental to the removal of ash has not been considered. This is in line with the policy laid down in the previous discussion on labor. Later, should we wish a more elaborate system, we can go into further refinements under this head.

Repairs—Under this head must be recorded all purchases of materials and all bills for services rendered by boilermakers, millwrights, machinists, and so on. Whenever the materials are received, the quantity and kind should be entered in our book, even though we do not know the amount. Also, when a certain repair job has been finished by outside workmen, the date and kind of repair should be entered. If the work is done by our own men, it is only necessary to enter the materials used, since we have agreed not to separate the total wages into different parts.

Scale Removal—Ordinarily, the only items that we need be concerned with here are such things as compounds bought to eradicate scale or facilitate its removal. They should be treated in a manner similar to that discussed for lubricants. Here again it will be noted that labor is not taken into consideration.

Miscellaneous Supplies—Whatever purchases cannot be classed under one of the foregoing headings may be considered as miscellaneous items. Such things as waste, charts for recording instruments, etc., would come under this heading. They should be entered in the memorandum book as soon as received, whether or not they are entirely used in the month.

Investment—Although the items that belong under this heading have no direct bearing on the cost of producing power, still it is necessary to insert it here so that no mistakes will be made in classifying some of the purchases that are made. For example, if it is necessary to buy new packing for a pump, we would naturally enter it as repairs. But suppose we buy a new pump. Under what heading shall we enter it? Certainly not under Repairs. The only class available would seem to be Miscellaneous Supplies, but it is quite evident that a pump is not supplies. As a matter of fact, the purchase of a new pump adds a permanent value to the plant; permanent in the sense that it is not immediately used up like coal or oil. In other words, it is an investment in machinery. When such items are entered in the record book, we must be very sure to classify them properly so that they will not get mixed up with any other class, for we must not consider the cost of purchase entered in the book as being one of the costs of producing power during the month. In this respect entries for investments differ from any of the others that have been investigated; all the others are a direct part of the cost of producing power during a certain month.

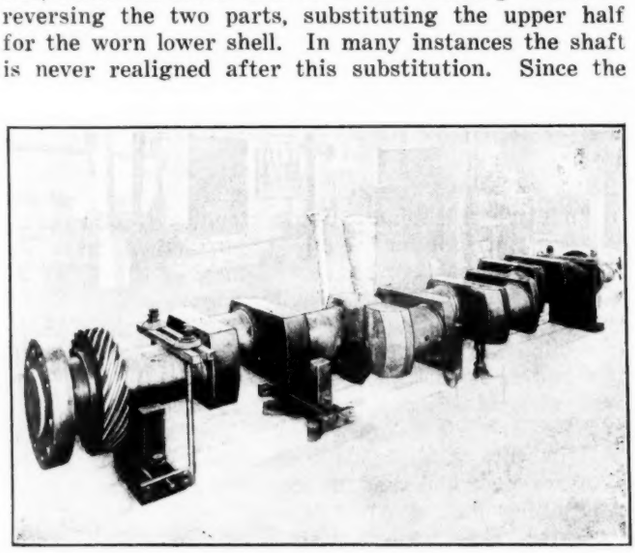
The best time to begin the record is on the first day of a month, although it may be started at any time. When the end of the month comes, we should have entries for every item up to that time. The next month's entries are then started on a new page and continued along in the same way as before. Turning back to the finished month we may find many entries for which we have been unable to enter any amount. Before the month's entries can be called complete we must get these. The bookkeeper is the person who should be able to give them to us, and there is little doubt that they will be made available if we tell him or the manager the purpose for which we want them.

After all our entries for the month are completed, we can proceed to sort them out in a little better shape. Just how to do this will be explained in the next article. Before closing this one, it will be interesting to know that the memorandum book in which all our entries have been made is practically what a bookkeeper would call a journal. Instead of calling it a memorandum book in the future, we may call it by its more formal name. A cheap paper-covered book of this sort, already ruled, can be bought at any stationery store. This will save you the trouble of ruling your own.

## Repair of Oil-Engine Crankshaft

By J. Wilson

The breaking of crankshafts of internal-combustion engines is in almost all cases due to negligence on the part of the operator. Many engineers follow the practice, when the lower half of a main bearing wears, of reversing the two parts, substituting the upper half for the worn lower shell. In many instances the shaft is never realigned after this substitution. Since the new shell is thicker than the partly worn ones under the other journals, the shaft is slightly bowed. This finally causes the shaft to break at the weakest section.



WELDED CRANKSHAFT

The illustration shows a fractured four-throw crankshaft after being repaired. The shaft broke owing to poor alignment. A bearing had been rebabbitted and placed back in the engine without realignment of the shaft. The bearing was merely scraped to fit the shaft and, being too thick, bowed the shaft.

To avoid the purchase of a new shaft, the two pieces were leveled up on an iron surface set into the concrete floor. The thermit process was used and the shaft, after the risers were removed, was trued at the crankpin and replaced in the engine. The service since secured proved the aligning and welding to be satisfactory.

# Internal-Combustion Engines*

## Problems Encountered in Using the Present Liquid Fuels in the Combustion Engine

BY CHARLES E. LUCKE†

ALL engineers are interested in the internal-combustion engine, even though not directly concerned with its development, because it stands for the highest present-day efficiency in the transformation of heat into work. It is the most efficient prime mover using heat as the source of energy. Its promise of high efficiency on fundamental grounds is very old, but it is only within the present generation that hope has become even an approach to reality. Commercial success has become real in more and more fields of use and application all the time, and today we are able to appraise the situation as never before.

During this period of development and of realization of the possible efficiency, the steam turbine has gone through its own period of development and is now approaching what is admitted to be its limit. At this time when the limit of efficiency of the steam turbine is in sight, the internal-combustion engine of good design is actually twice as efficient, with the promise of more to come. Even with poor design or unfavorable conditions of operation, the internal-combustion engine as to efficiency is just about as good as the best steam turbine of the largest size.

In spite of many discouragements, the internal-combustion engine has gone ahead and is today becoming a dominant factor in transportation. This phase of the problem—the rise of importance of the liquid-fuel development in the combustion-engine field—is worth while analyzing.

### HIGH EFFICIENCY REQUIRES HIGH COMPRESSION

The first lesson taught by the gas-burning engine is, the higher the efficiency the higher must the compression be. That is as it should be on thermodynamic grounds, and experience has amply demonstrated the validity of the theory. To attain the highest efficiency requires the use of the highest compression, but this cannot have any higher value than the ignition temperature of the mixtures of fuel and air.

The second lesson is that, in addition to high compression, high efficiency is obtainable only if combustion is carried out in a correct and proper manner. The combustion line should approach a vertical line on an indicator diagram, somewhat like that shown in Fig. 1. This is obtained by timing the ignition, for the rate of combustion in its relation to the piston speed determines the shape of the line, and each mixture has its own rate of flame propagation. A slower-burning and weaker mixture can be made to give substantially the same indicator diagram by a further ignition advance, producing a diagram somewhat like that in the dotted line, Fig. 1. These two lessons are important for the adaptation of liquid fuel, because with the ideals in mind other means of securing proper combustion must be sought in special cases.

*This article is part of an address given by the author before the Boston section of the American Society of Mechanical Engineers; other portions will appear in later issues of *Power*.

†Professor mechanical engineering, Columbia University, New York City, and consulting engineer, Worthington Pump and Machinery Corporation.

In addition to the two lessons of high compression and of proper control of the combustion line as to shape and location the gas-burning engine has also demonstrated that, to get the maximum results in both power and efficiency, it is equally necessary that the fuel be intimately and homogeneously mixed with the air throughout its entire mass and that the cylinder be fully charged with that kind of mixture. In proportion as the mixture departs from a condition of uniformity and intimacy, and as correct compression and proper timing of combustion are not attained, so will the engine fail to yield the promised high efficiency that thermodynamic analysis has indicated is possible.

In addition to these principles of combustion for transforming high percentages of heat into work, the building of gas-burning engines has established many basic principles in the structural problem. To make cylinders, pistons and heads that will not crack, is not

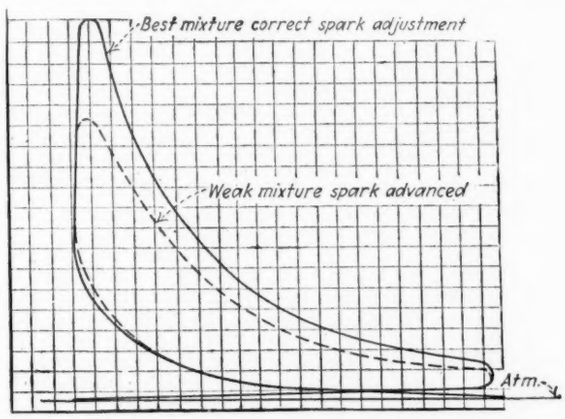



FIG. 1. TYPICAL INDICATOR DIAGRAM FOR GAS ENGINES

as easy as it looks, and practically all builders of engines had their first ones crack. But taking the experience of the world at large, it can be said that the means of avoiding fractures have been discovered.

In the adaptation of liquid fuel there are certain special problems that have to be faced which did not exist with the gaseous-fuel internal-combustion engine. The two principal classes of problems are the fuel itself and the special type of service to be met. It very early appeared there could be no such thing as a universal liquid-fuel engine equally adaptable for gasoline, kerosene or fuel oil, or equally good for boats or automobiles or aircraft. There might very well be an automobile engine, or a motor-ship engine, or a tractor engine, or a railroad engine, or a stationary electric-lighting set engine, but each must be built to meet the specific duty.

It is this adaptation that occupies most of the period of development. To study the fuel phase of liquid-fuel adaptation, fuels must be divided into the two classes that are now found commercially. The first class includes fuels that are sufficiently volatile to make a more or less homogeneous and gaseous mixture with air, by

passing through so simple a device as a carburetor, which is similar to the older air-gas mixing valve of all gas-burning engines. By using a volatile liquid fuel in a carburetor, replacing the air-gas mixer, a gas-burning engine becomes a gasoline engine, and all its principles apply in regard to the combustion control. There is left, therefore, nothing more than the mechanical adaptation of the metal parts to the speeds, weights, power, load and torque requirements of the motor vehicles and boats. With that problem solved, it would seem as if a perfect gasoline engine had been evolved, and for a time it was almost true.

The other class of liquid fuel may be termed the non-volatile, and it includes anything that could not be used in such a carburetor with or without heat, but this fuel requires a device that must be built into part of the engine structure, rather than a device or attachment to what would otherwise be a gas engine, thus imitating the injection oil engine.

### Supply of Volatile Fuels Diminishing

The really difficult problem of the gasoline engine appears only when it is realized that the fuel is no longer volatile enough to make the desirable homogeneous mixture, but not bad enough to require an injection engine. As time goes on, the supply of volatile fuels is decreasing through greatness of demand, so the situation changes before the old problem is really solved, and in facing new conditions the necessity arises for again changing the engine design. The continuation of this decreasing of gasoline volatility will drive us from the more-volatile into the less-volatile fuels and will again force a change of engine for at least part of the transportation service to the more modern style—the injection engine. This is the type that is becoming of increasing importance. Before getting down to the problem of the injection engine proper, it is desirable to analyze some of the difficulties with the problem of

COMPRESSION PRESSURES WITH GASOLINE FUEL

| Temperature Before Compression. F. | Compression Pressure to Produce Temperature of 786 Deg. F. | | 886 Deg. | | 986 Deg. | |
|---|---|---|---|---|---|---|
| | $n = 4/3$ | $n = 1.4$ | $n = 4/3$ | $n = 1.4$ | $n = 4/3$ | $n = 1.4$ |
| 0 | 786 | 462 | 1055 | 610 | 1400 | 789 |
| 50 | 504 | 317 | 698 | 425 | 833 | 545 |
| 100 | 341 | 225 | 472 | 302 | 639 | 391 |
| 150 | 239 | 163 | 331 | 219 | 443 | 284 |
| 200 | 172 | 120 | 240 | 163 | 323 | 213 |
| 250 | 125 | 91.1 | 175 | 123 | 238 | 162 |
| 300 | 91.3 | 66.2 | 131 | 92.6 | 178 | 125 |
| 350 | 66.2 | 50.0 | 98.5 | 70.5 | 135 | 95.5 |
| 400 | 47.5 | 38.2 | 72.0 | 54.4 | 103 | 75.0 |
| 450 | 35.3 | 28.0 | 54.3 | 42.6 | 77.8 | 58.8 |
| 500 | 26.5 | 22.1 | 41.2 | 32.3 | 60.2 | 45.6 |

Ignition temperature, 986 deg. F.

adapting the gas-burning engine and its principles of good utilization, to light and then to heavier gasoline.

The first principle of maximum compression cannot be carried as far as is desirable because the ignition temperature of these gasoline mixtures is lower than the ignition temperature of the gases that form the bulk of the fuels for the gas-burning engine. Furthermore, the temperature of the mixture before compression is no longer under the complete control it used to be with cold gas, and the temperature at the point of ignition or when compression ends, is as much a function of the temperature before compression begins as it is of the ratio of pressure increase.

To make clear the importance of initial temperatures in determining the pressure that will produce the ignition temperature, or 100 deg. less than ignition temperature, Table I has been calculated. Compression in the carburetor engine cannot be carried quite to the ignition temperature, because that would leave an element of danger. A slight warming up of the entering charge would mean loss of control and automatic preignition. Taking the ignition temperature of the gasoline as 986 deg. F., determined by the compression method (which is the only method that gives results anywhere nearly accurate), it appears that if the initial temperature before compression is zero F., it would require a compression of about 790 lb. to produce a temperature of 986, the ignition temperature, according to the law $PVn = C$ if $n$ is 1.4, and 1,400 lb. if $n$ is $\frac{4}{3}$. The truth is nearer the value for $n = 1.4$, so these figures are used. If the temperature of the entering charge rose to 300 deg. F. before compression began, then 125 lb. compression would produce ignition. To keep the mixture temperature below ignition temperature by 100 deg. would require a reduction of compression from 125 to 93 lb. If the initial temperature were 400 deg. F., and that is by no means unusual, then to produce ignition temperature would require only 75 lb. compression, and to keep 100 deg. F. below ignition temperature a compression of 54. This explains why in the first place high compression cannot be used in any case with gasoline, and why in one type of engine a higher compression can be carried than in another, the temperatures before compression are different, and the margin of reserve against preignition is also different in different types of service, such as aircraft as compared with trucks for example.

### Efficiency in Direct Ratio to Perfection of Mixture

The conclusions reached by the gas-burning engine, with regard to mixture quality, proportionality, homogeneity, intimacy, are all verified with gasoline. The efficiency secured is in direct ratio to the perfection of the mixture attained with the volatile liquid fuel, but the limit of attainment and the realization of it both fall off as the volatility falls off, and with the gasoline we are now using, approximately one-half does not vaporize in the intake passages.

The half that does not vaporize is carried along in three different states: (a) As a film on the walls, such as rain will form on the window pane; (b) as a fog that floats; and (c) as a rain that is falling or driven by the air currents. A fog turns into rain and the rain makes films. No amount of ingenuity with devices such as screens, baffles or paddles can prevail, because these cannot overcome the laws of liquid flow and vapor pressure that are operating. This is a problem of serious importance, because if that unvaporized liquid fuel gets into the cylinder and strikes a hot spot, such as the piston head, it will vaporize there locally, and will form on the piston head a pancake of vapor that will have displaced the air and not be mixed with it. That vapor pancake, when combustion takes place above it, is simply heated to its decomposition temperature, producing carbon and, though actually not burning itself, fouls up the engine and interferes with its smooth operation.

If the unvaporized fuel entering the cylinder strikes on a cold cylinder wall, it will run down past the piston into the lubricating oil. This unvaporized fuel is mainly kerosene and the lubricating oil is also a petroleum product and both are mutually soluble. The mixture is no longer a lubricant oil. It runs down into the crankcase and destroys the lubrication of the main bearings, and the crankpins, as well as the piston pins. How

can these things be prevented from happening? Unless they are prevented, the engine is no longer commercial.

Two courses of action are open. The first is to heat the mixture as it leaves the carburetor, and thereby raise the vapor pressure to a point where in a 15 to 1 proportion there will be a vaporized fuel and air mixture at the minimum possible temperature and at a pressure of one atmosphere. This will require, for the ordinary gasoline, a temperature of about 120 deg. to "dry" the mixture—using a steam term. It will require for kerosene about 215 deg. to dry the mixture, and when to these manifold temperatures are added the suction heating, the suction temperature becomes so high as to make it necessary to lower the compression to avoid preignition. Such lowering of the compression produces loss of power, efficiency and mileage. It may be said, therefore, that a moderate amount of heating is permissible, and possibly a sufficient amount of heating to completely dry the mixture if the gasoline is not too heavy, but complete heating for a kerosene mixture is not permissible. Gain will be realized, but also a loss, and the loss will overbalance the gain, and the practice must be abandoned.

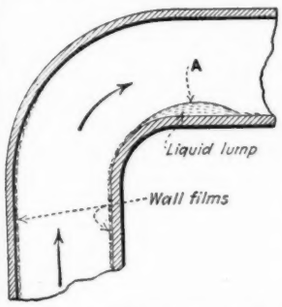



FIG. 2. ACTION OF GASOLINE IN INTAKE MANIFOLD

### Handling Wet Mixture

The next mode of attacking this problem is to try to handle the mixture with some of the fuel as a liquid. To handle a wet mixture in the modern multi-cylinder engine necessitates the distribution of the stream of liquid as it runs along on the inside of the pipes to four, six or more branches, giving to each branch the same amount of liquid, in order that all cylinders may work the same, assuming the liquid will be vaporized as it enters each cylinder. Imagine the liquid coming up the side walls of the riser and approaching a bend as in Fig. 2. How would it turn? Almost everybody would say it would collect on the outside of the bend, because of the inertia being greater for the liquid than for the air, and yet observations in glass manifolds show that the liquid forms a very substantial lump at *A*, just beyond the turn and on the inside of the bend. This does not, however, dispose of the action of inertia as a separating means at all. It is really confirmed, because a separation does take place. Films collect at the outside of the bend, but the velocity of the air-vapor mixture is so great at that point as to drive the liquid film around the bend to the point of least velocity. It is really the shape of the air stream that the plug of liquid reveals. Therefore, if the gasoline is not very heavy, a moderate heating of the mixture with some form of hot spot is the right thing—not too much—so as to avoid preignition, and with this moderate heating a manifold will take care of the rest of the liquid. If the volatility of gasoline decreases much more, a complete change of the procedure will be necessary.

The net result of all this is that the gasoline-carburetor engine is approaching a crisis in its history that is going to force the use of radical remedies. The remedies now being considered are as follows:

First, the elimination of the manifold entirely. This will take away the distribution problem. It will permit the delivery of the liquid as a liquid with its air into the cylinder directly. No particular spraying is needed and not much vaporizing, because by properly forming the inlet valve and its passages, a combustible mixture will be formed as the charge enters the cylinder. This method has proved successful, and it is now the standard in use for all farm and most tractor engines, several hundred thousands of which are made every year, burning kerosene without any mixture heating whatever, beyond what is incidental to suction.

The second remedy being studied is the changing of the volatility of the gasoline by mixture with another and more volatile fuel, leading to so-called and misnamed "synthetic fuels." By properly selecting the things to be added to the gasoline, it is possible not only to improve the volatility, but at the same time to raise the ignition point. Just as water or steam or neutral gases added to the mixture will raise the ignition point, so will some other fuels, among them benzol and alcohol. Experiments with a benzol-alcohol-kerosene mixture at

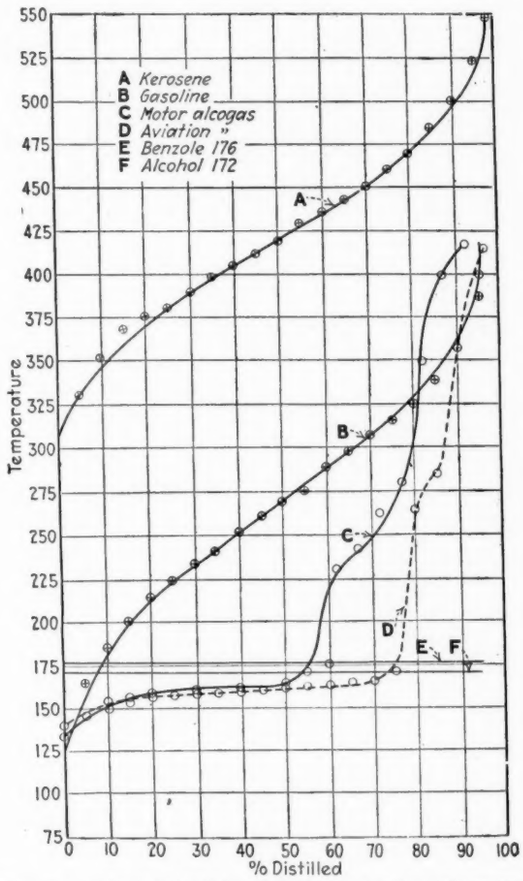



FIG. 3. DISTILLATION CURVES OF LIQUID FUELS

Columbia University have yielded truly wonderful results judged by the possibilities of the future. It is amazing to what extent compression can be raised on a charge of gasoline with a minor amount of alcohol added. This is also true with benzol. Such mixtures carried the German aircraft through the war. The Germans had but little of the light volatile gasoline, but they did use these mixtures. There is a measure now before the French government to adopt a single standard mixed liquid fuel, composed of alcohol, benzol and such petroleum distillates as they can secure, as the

one French National motor fuel. It is a queer thing how a little alcohol, itself having a high ignition temperature, added to gasoline, can raise the ignition temperature of the whole nearly to the value of the alcohol. Why it should act so is not clear, but it does, nevertheless.

An examination of the distillation curve of gasoline or kerosene, or even a heavy petroleum product, shows it to have the general shape of Fig. 3. Standard gasoline will start to distill at about 125 deg. F. and end at about 425 deg. F. If benzol or alcohol be added, the shape of the curve is not changed, because the two constituents have each a straight distillation line at the constant boiling point, but what happens is that the volatile zone has widened out. At any given temperature, say 70, 80 or 90 deg. F., where there is a larger percentage of volatile, there is a smaller percentage of non-vaporized liquid to be handled by the manifold. This is the second possible remedy. The first was to eliminate the manifold, with direct introduction from carburetor to cylinder, and the second, to add to the gasoline in whatever proportions can be had—whatever the national supply will permit—things like benzol or alcohol.

The third remedy—and this is the radical thing—is to abandon the mixture engine entirely and take up the injection engine. The abandonment of the carburetor engine, or the premixture engine, is a thing which should solve the present fuel problem as we hear of it, and that is a real problem.

In case of successful development—and there are many people working on it—of a suitable injection engine, the problem of gasoline shortage disappears, because the injection engine can handle any petroleum distillate, any coal-tar product, any alcohol or similar fuel, subject to one condition—that it shall be of proper fluidity to pass the pump valves and spray orifice. If the fuel is not naturally of high fluidity, there is not one that cannot be made of proper fluidity by adequate heating.

# Water in a Refrigerating System

By M. C. JACKSON

THE suction stop valve on one of two vertical single-acting machines in a packing plant appeared not to seat properly, and it was decided to open it up and examine it. With this machine the suction valve was located at the bottom and was provided with two bypass connections and a blind flange on one side. This we first removed, thinking that we might be able to get a look inside through this opening with the aid of a flashlight, as it was possible that a piece of packing or other material had caught on the seat.

When this flange was removed, or rather loosened, a yellowish liquid began to trickle out, being a combination of water, oil and ammonia. A pail was put under the opening to keep from messing up the machine, and altogether three pailfuls of liquid were removed through the opening.

Evidently, this liquid had rested in the short passage from the valve to the cylinder, in the valve, and in the cylinder. No matter where it was located, it was bad business. The first and most important problem was to determine where it came from and the next to remove the rest of it from the system, as it was not reasonable to believe that all of it had found its way to this machine and accumulated there.

We remembered that we had heard several severe thumps in some of the machines at different intervals and these had not happened while the machines were running cold, which is generally the case if the thumps are caused by liquid in the suction gas. This led to the conclusion that the entire system was contaminated with water or brine from some source, and it was up to us to get busy right away or we would be liable to have a wreck.

## Testing for Leaks

We tried the suction valve on another machine and found the same thing. The liquid ammonia was next tested and considerable water was found in it. The real problem was to find where it came from. We tried every test on the brine tanks that we could think of without detecting anything that could be considered a leak. First, we shut the tank down and let the brine stand in it while we pumped a pressure of about 60 lb. on the coils. We tested the brine with litmus paper and and finally with Nessler's solution without finding any ammonia leak. We then pumped the brine out and pumped 100 lb. pressure on the coils and went over them with a sulphur stick and still nothing suspicious was detected.

The same "stunts" were tried on the water jackets of the compressors, thinking that there might be a considerable leak in the compressor and that the water had been drawn in at some time while pumping down. Not a sign of a leak was found here and the only place left was the condenser.

Now it would not seem reasonable that any water could get into the system through the condenser because the condenser pressure varied from about 145 lb. in the winter time to about 185 during the hot spell in the summer. There was a cooling tower on the top of the engine-room roof, and the condenser was just outside of the engine room on the same level, leaving a head of about 50 ft. on the condensers, which would amount to only a little over 20 lb. pressure. It was evident that as long as the condenser ammonia pressure was so much higher than the water pressure, no water could get into the system from this cause.

This was during my "cub" days as an engineer, being in charge at that time of the power generators of the plant, while another man and the chief devoted most of their time to the refrigerating equipment. I remembered, however, that about a month before we had found a split pipe in one of the condensers, which were of the double-pipe type. The coil had been shut off and pumped out, and we intended to repair it as soon as we could find time to attend to it.

While the chief and the man in charge of the ice machines were scratching their heads and trying to figure out where to look next, I was trying to reason out how this stand with the split pipe, which was supposed to be pumped out, could get water into the ammonia system.

We generally used one of the smaller machines, which

worked on the freezers at a back pressure of about zero to three or four pounds, for pumping out. After thinking the matter over, I came to the conclusion that if the valves in the pump-out line and that on the coil that was out of service, were not closed tight and the water valves on this stand leaked, the water would leak through the water valves, fill up the stand, seep through the split pipe in the stand and be drawn into the ammonia system through the pump-out line.

### Condenser Filled with Water

To test my theory, I went out on the condenser in which the defective coil was located, and saw to my surprise that the pump-out valve on the stand was wide open. I next tested the three-way cock on the bottom and found that the coil was full of water. The bottom cock did not fit tight, and when it was supposed to be shut off considerable water seeped through—enough to fill up the coil in a few hours.

Going back to the engine room, I next turned my attention to the stop valve in the pump-out connection to the low-pressure machine that we generally used for pumping out. When I came to this, I was quite sure that I had the solution of the trouble because the valve was nearly full open. After pumping the ammonia out of this coil, the valves evidently had never been shut either at the machine or on the condenser, and after getting all the gas out it had started to pull the water through the split in the pipe as fast as it leaked through the leaking three-way cock at the bottom. This water then mixed with the liquid ammonia.

When I put my idea before the chief, he at first gave me the laugh. I dared them to break a flange joint in the pump-out line to see if it was not full of water, and he finally thought it worth while looking into. The two valves at each end of the line were shut off, and the moment the joint was broken the water first poured out in a steady stream. There was no further argument about where the water came from, but the big problem was now how to get rid of it.

### Home-Made Ammonia Still

After considering a number of plans, we decided to install three ordinary steam separators, but designed for 250 lb. pressure, in each of the suction lines. The drain lines from these separators were connected to a home-made still of the usual tank and steam-coil design, which we made of scrap material.

This was made up of a piece of 12-in. pipe with flanges on each end. Holes were drilled in one of the flanges on one end, and through this was fitted the pipe coil. One end of this coil was connected to the steam line, and at the other end was a trap of the thermostatic type. A blowoff pipe with a valve in it was fitted to the bottom of the still for blowing off the water that was distilled out and oil and other foreign matter.

The three traps were piped so that any one of them could be connected to the still as desired. At the other end of the still was a connection with one branch to the low-pressure suction line, which was generally used, and another to one of the high-pressure suction lines, to be used in case the low-pressure line was out of service.

The three steam separators acted exactly the same as they would if the lines had been carrying steam instead of ammonia. The entrained moisture and water was caught in the separators and drained from these into the still, one at a time, as otherwise the gas would blow through the high-pressure separator and through the manifold connection and back into the other suction lines that carried lower pressure. By draining only one separator at a time, this was prevented. With the other end of the still connected to the low-pressure suction line, there was a positive blow through from the receivers in the other lines, through the still and into the low-pressure suction line.

The gage glass at one end showed at all times just how much liquid there was in the still. When it was full the inlet valve was shut off and the steam turned on. It was only a short time before the ammonia would be distilled off, as indicated by the gage on the still. This could readily be checked by shutting off the valve to the suction line and watching the gage. As soon as the still was cleaned of one charge, another was let down from the separators.

For the first two days one man was kept on the job all the time attending to nothing but the still, and several barrels of liquid was drained from the system. After this the moisture began to come back more slowly, and we would leave one separator connected to the still for a while and then shut it off and turn another one on for a few hours until the still got full. This was kept up for about three months, and by this time it was comparatively clean and the expansion coils had an entirely different action from what they had had for a long time.

To help clean the expansion coils we would occasionally shut off all the expansion valves but one on a system of coils and then shut off the liquid valves on all the condenser stands but one; by this means we were able to blow hot gas directly through the single condenser stand, on which the water was turned off, through the liquid receiver and liquid line and through the one open expansion valve and right through the one coil into the suction. In doing this, we got large quantities of moisture back through the separators. The expansion coils were treated one at a time in this manner, which not only helped to remove the frost on the direct expansion coils, but also blew out what oil had accumulated in them, together with the moisture and other foreign matter.

The still was left as a permanent fixture in the plant and one of the separators was kept connected to it. By this means the ammonia in the system was kept practically pure, and if at any time water or brine found its way into the system it would be indicated at once by the increased accumulation in the still. The cost of operation was practically nothing and it required but very little attention, one of the men switching from one separator to the other about once every day.

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The Swiss railways have been running a series of tests on a turbine locomotive, equipped with a condensing Zoelly turbine with spur-gear drive. This locomotive does not differ much from the average reciprocating type. The turbine is mounted in front of the smoke box and the condenser beneath the boiler. The condensing water is cooled in a cooler carried by the tender, by spraying a fraction of the water into air currents produced by the motion of the locomotive. The water consumed in this way is said to be considerably less than that of the ordinary type of locomotive, while the use of hot condensate and a heater for the feed water results in considerable fuel economy.

# Obtaining Test Load for Main Units in Power Stations

## Water Rheostats for Absorbing Load in Connection with Plant Tests on Both Steam- and Waterwheel-Driven Generating Units

By C. W. LEONARD

WHEN it becomes necessary to make full-load test runs on steam-turbine- or waterwheel-driven generating units after they have been installed at the plant, it is sometimes difficult to adjust and maintain the load constant at values desired on the test curve. On large power systems a unit under test can frequently be satisfactorily loaded by setting the governors at the desired point with arrangements for other generating plants on the system to take care of fluctuations. When this cannot be accomplished, load-absorbing devices, such as rheostats, must be considered.

The following describes simply constructed water rheostats successfully used for the testing of three completed power plants. Plant "A" is a steam-turbine station having a total of four 2,500-kw. 2,300-volt three-phase generating units, with voltage stepped up to 22,000 volts for transmission by means of transformers having windings that could be connected for 11,000 volts. Opportunity for test was presented before it was possible to secure satisfactory load from the system on account of the lack of proper line connections,

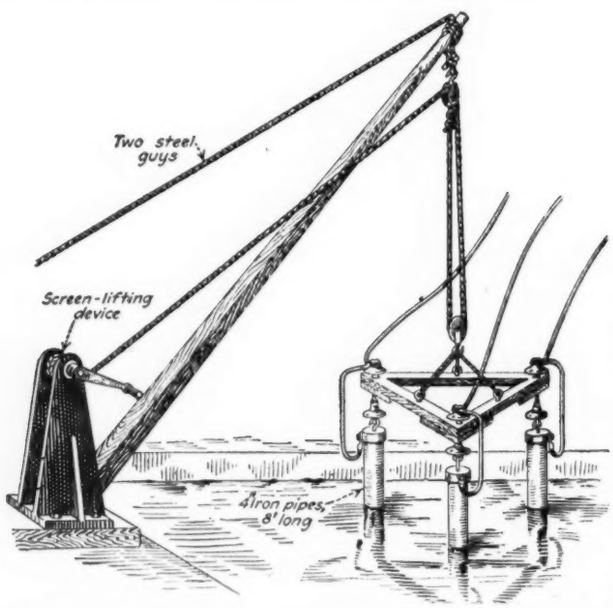


FIG. 1. RHEOSTAT FOR LOADING 2,500-KW. GENERATOR AT 11,000 VOLTS

and it was decided to experiment with water resistance as a means of absorbing energy during the tests.

This plant was situated on the bank of a river from which the supply of condensing water was obtained, and the intake chamber offered an ideal pool for these experiments. A wooden framework of equilateral triangular form with sides 3 ft. long was constructed. At each apex standard pin-type line insulators were mounted to provide means for connecting the line conductors. Three electrodes, each consisting of sections of 4-in. wrought-iron pipe 8 ft. long were attached to the under side of the framework by means of suspension insulators and connected by short leads to the line wires.

The completed apparatus was suspended from a wooden shear leg projecting over the forebay by means

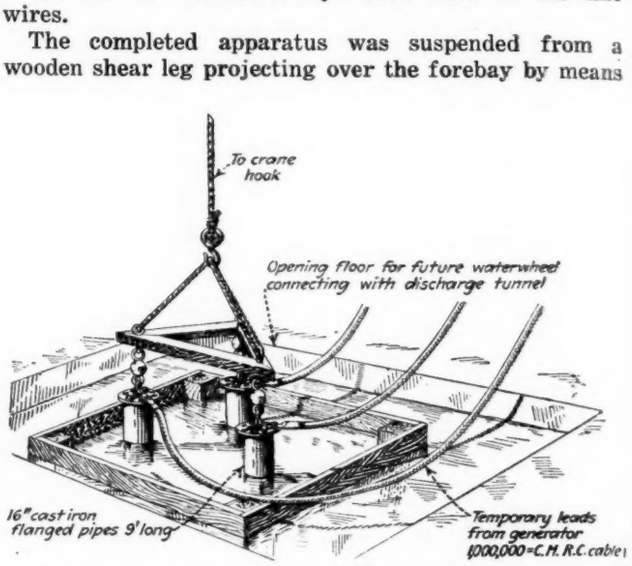
To crane hook
Opening floor for future waterwheel connecting with discharge tunnel
16" cast iron flanged pipes 9' long
Temporary leads from generator 1,000,000-C.M. R.C. cable

FIG. 2. RHEOSTAT FOR LOADING 3,125-KW. GENERATOR AT 2,300 VOLTS

of a cable which, after passing through a sheave block at the top of the shear, was wound around the shaft of one of the intake-screen operating mechanisms in such a manner that the latter could be conveniently used for raising and lowering the electrodes as might be necessary to secure the desired adjustments. The general arrangement of this equipment is shown in Fig. 1.

It was found that full load at 11,000 volts could be obtained with about 6 ft. of electrode immersed and that fractional loads could be obtained with exactness by adjusting the depth of submergence. This arrangement was satisfactorily used to make water-rate tests on two of the turbo-generator units.

Plant "B" is a hydro-electric plant with two 3,125-kva. 2,300-volt three-phase units installed at the time of the test. The voltage was stepped up to 44,000 volts for transmission. As this plant was completed several weeks in advance of the transmission line, it was expedient to make complete full-load tests to see that everything was in proper condition, so that the construction force might be released. Short-circuit heat runs were first made on the generators to dry them out. Then they were slowly brought up to normal voltage. After the transformers were dried by hot air and the oil treated to remove water and to bring it up to the necessary test voltage, they were completely assembled and made ready for service. Each of the two transformers was then given a full-load current run

with the high-tension coils short-circuited to make certain that all connections were in good condition, and later slowly brought up to voltage, using a separate generator for the purpose.

It was then decided to make a full-load run of at least 24 hours' duration on each of the generators if possible. In the power-house floor there were two wheelpits that had been boarded over with a temporary flooring. These pits connected with the river by means of discharge tunnels, and the water in them stood but a few feet below the power-house floor. The tests on plant "A" suggested the possibility of these units being successfully tested at the lower voltage of 2,300 volts, using the wheelpits for the purpose. Preliminary tests were made to determine the probable surface and spacing of electrodes required at 2,300 volts, using water from the river. From these tests it seemed that about 28 sq.ft. per phase per electrode would be sufficient if they were located on about 4-ft. centers, which was as close as was deemed advisable with such large electrodes unsupported at the bottom. Using this data as a basis, the arrangement shown in Fig. 2 was constructed.

The electrodes were made up from short sections of 16-in. cast-iron flanged pipe which happened to be on hand. These were bolted together to form three lengths of about 9 ft. each and were suspended from points 4 ft. center to center by means of cables and strain insulators from the corners of a triangular wooden framework.

The completed arrangement was suspended by means of a line attached to the crane hook inside of a box with 8-ft. sides made of 2-in. planks laid with open joints about ½ in. wide. This was submerged in one of the unused wheelpits and wedged into place. This box was used to protect the electrodes from any débris that might be washed in from the river. It later proved to be indispensable in facilitating the control of resistance by means of salt solution added to the water in the box, since the 28 sq.ft. of surface counted on as sufficient would not give quite full load at 2,300 volts. Three temporary cables of 1,000,000 circ. mils cross-section were run over the floor from the generator oil switch to connect with the rheostat and bolted to the electrodes through holes in the pipe flanges.

It was found that with 7 ft. the maximum submergence of electrodes, only about 75 per cent of full load could be obtained. This meant lower resistance of water if the equipment was to be utilized as constructed. Small amounts of saturated solution of common salt poured slowly into the box occasionally in conjunction with field adjustment on the generator solved the problem, and by this means the load could be held sufficiently constant. This method was used with entire success throughout the run of 24 hours on each of the generators.

After these tests and a thorough test of the exciters, the switchboard, and oil circuit breakers, the plant was found to be in such good condition that it could be turned over to the operating force. Several weeks later, when the line was completed, the plant was placed in service without loss of time, because of the previous thorough testing of the equipment.

Plant "C" is a hydro-electric plant having four 4,000-kva. 2,300-volt three-phase generators installed. Voltage is stepped up to 66,000 volts for transmission by means of transformers with double windings which can be connected for 33,000 volts.

The artificial loading of generators at this plant was necessary in order to conduct satisfactory efficiency tests on the waterwheels. The loading device had to be placed in the river because water was discharged from the wheels at a point several feet above the normal river-water level and at points about 150 ft. distant from the river's edge. The water at the point selected was 20 ft. or more in depth and the velocity of flow from 10 to 15 ft. per sec. It was decided that a suitable test loading device could be secured best by utilizing a log raft anchored in place by means of cables from points on both sides of the river. The arrangement shown in Fig. 3 was constructed for a tryout, and a temporary 33,000-volt line about 250 ft. in length was built to connect with one of the high-tension line exits at the plant. One bank of transformers was reconnected for 33,000 volts, which by means of double busbars could be connected with any one of the four generators.

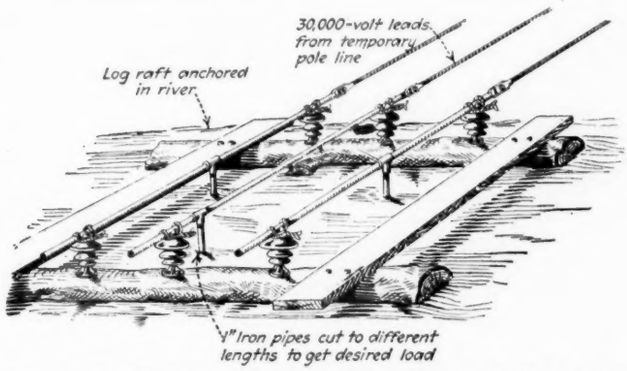
30,000-volt leads from temporary pole line
Log raft anchored in river
4" Iron pipes cut to different lengths to get desired load

FIG. 3. RHEOSTAT FOR LOADING 4,000-KW. GENERATOR AT 33,000 VOLTS

Across the three pairs of line insulators mounted on the raft, three pieces of 1-in. iron pipe flattened at one end to receive the line conductor were laid and tied in place. Each pipe was made up with a tee inserted at a point that would place the three 1-in. drops into the water at the corners of a 6-ft. equilateral triangle.

Three lengths of pipe were screwed into the tee connections, leaving about 5 ft. of electrode immersed for a tryout. It was found that the resistance was entirely too low and that the surface exposed would have to be reduced. A second tryout was made with 3 ft. of pipe immersed. After this change it was found that about 85 per cent of full load could be absorbed at normal voltage of 33,000 volts and that the performance was entirely satisfactory, for the load was very constant in spite of a considerable amount of boiling at the electrodes.

Pipes of different lengths to give 25 per cent, 50 per cent, 75 per cent, 100 per cent and 125 per cent of full load were adjusted by the cut-and-try method. The correct length was found to be very nearly proportional to the load, so that little difficulty was experienced in determining the proper lengths. This load-absorbing device was used for several days to conduct efficiency tests on two units, and proved to be satisfactory. On account of the non-inductive character of this form of load all tests had to be made at unity power factor. When the foregoing method of loading is not applicable, good results can be secured by means of iron-wire coils connected between phases and entirely submerged. Many plants have such devices installed for emergency use in case the entire load on the plant is suddenly interrupted.

## Progress in the Use of Peat

By K. Rankin

Peat has long been used by the peasants of Europe as a fuel—it has always been Ireland's principal fuel. Since the Germans lost the rich coal fields of Alsace-Lorraine, they have turned their attention to peat as a precious natural resource that will help them get along with less coal. America has as yet paid little attention to its vast peat deposits—the coal fields of future ages—because she has been nonchalantly squandering the resources with which Nature has so liberally endowed her. In Europe it is a different matter, for dense populations, keen competition, inherent thrift and ceaseless economic pressure have long combined to force Europeans to make the most of what they have.

It is estimated that there is 13,000,000,000 tons of peat on the 20,000,000 acres of peat-bearing lands within the United States. More than half of this is in Minnesota. As Minnesota is dependent upon other states for fuel, it is natural that her peat deposits loom big as a potential source of fuel. As might be expected, it is in Minnesota that the most work has been done toward the utilization of peat. Within thirty miles of Duluth the peat ranges from 1,000 to 18,000 tons of commercially dry peat per acre, the deposit varying from 5 to 90 ft. It has been estimated that this peat can be harvested, dried and prepared for domestic use at a cost not exceeding $1.25 per short ton.

Peat is nothing more than decomposed or decomposing vegetable matter containing about 90 per cent of extraneous moisture. It burns with comparatively little smoke and is quite readily ignited. In the past the high moisture content and the cost of gathering and drying have hindered it from becoming a commercial fuel in this country. The methods of attempting to burn it have still further discouraged whatever inducements there might have been for its use. The reported perfection of a machine that digs, macerates and cuts the peat into a ribbon about 3½ in. wide, suitable for air drying, so that only 25 per cent of the moisture remains, may change the situation. Peat made into briquets or, better still, pulverized, has apparently overcome most of the difficulties of burning for industrial purposes. It is undoubtedly in this latter form that peat will eventually be used for steam raising, briquets probably being used for domestic heat. Dry peat contains between 10,000 and 11,500 B.t.u. per pound.

Europe is consuming between 20,000,000 and 25,000,000 tons of peat a year for fuel, compared to the 150,000 tons or less used in the United States.

Wider use of peat would help conserve the forests. The Department of Agriculture has stated that American farmers last year consumed about 68,244,000 cords of wood for fuel, valued at $345,866,000. Peat could have been used in many cases instead of wood.

The gradual development of peat as a fuel is not an epoch-making event; it is merely incidental to the great movement that is taking place toward the conservation of our natural resources. But every incident is a step toward the goal.

## Two New Detroit Underfeed Stokers

Two new underfeed stokers have been put out recently by the Detroit Stoker Co., of Detroit, Mich. One of these, a single-retort, side-cleaning stoker, is intended for boilers up to 3,000 or 4,000 sq.ft. of heating surface; the other is of the multiple-retort end-cleaning type for larger installations. Among the principal features may be noted a level fuel bed, adjustable rams, auxiliary pushers with independent adjustment, hand-operated end dump, adjustable air intake under the stoker, and adjustable air admission over the fuel bed through ports in the front wall. The length of stroke is adjustable so that the operator may control the thickness and shape of the fuel bed, the adjustment of the stroke being effected by means of a block which may be pinned in any one of several holes in the connecting rod.

Retorts and tuyeres have been designed to operate at comparatively low air pressures and have been arranged to minimize clinker formation on the side or bridge walls. The air admitted through the tuyeres is forced through the fuel bed at right angles to the retorts so that the major portion of the fly ash and soot is kept in the stoker furnace chamber and not deposited in the front bank of boiler tubes. Side-wall tuyeres extend above the retorts and protect the brickwork from the clinker formation.

The ash dump has been arranged for hand operation, being lowered and raised by means of a worm and segment. With wide boilers, where stokers containing six retorts or more are employed, the dump plates may, as a matter of convenience, be arranged for handling in sections.

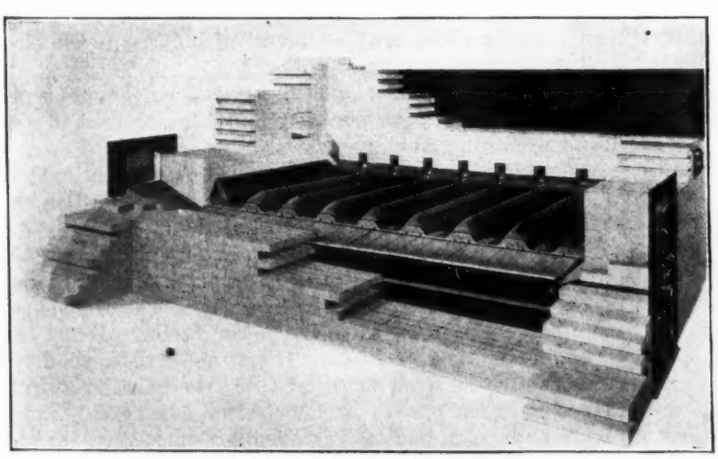

FIG. 1. REAR VIEW OF THE DETROIT MULTIPLE-RETORT STOKER

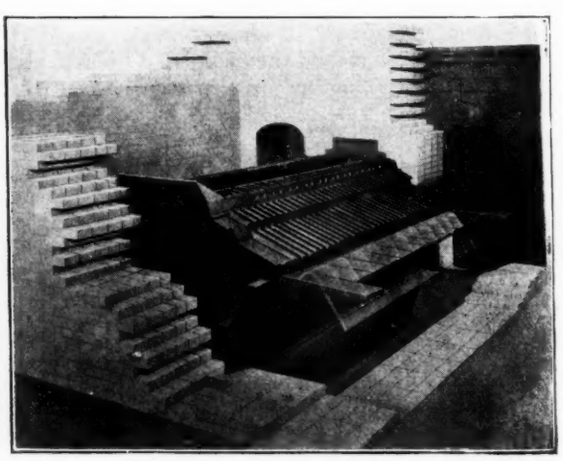

FIG. 2. SIDE-CLEANING FEATURE OF SINGLE-RETORT STOKER

Fig. 3 shows a test performance of the new underfeed stoker as reported by the builders at capacities ranging from 60 to 350 per cent of normal boiler rating. The flexibility is indicated by a test made on a 6,000-sq.ft. water-tube boiler on which the fire had been banked previously for four hours, with the boiler developing only about 10 per cent of normal rating. Within one minute after the heavy load was placed on the boiler, it was developing normal rating; within two minutes

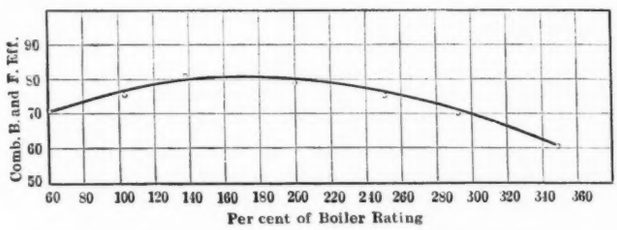


FIG. 3. TYPICAL TEST PERFORMANCE CURVE

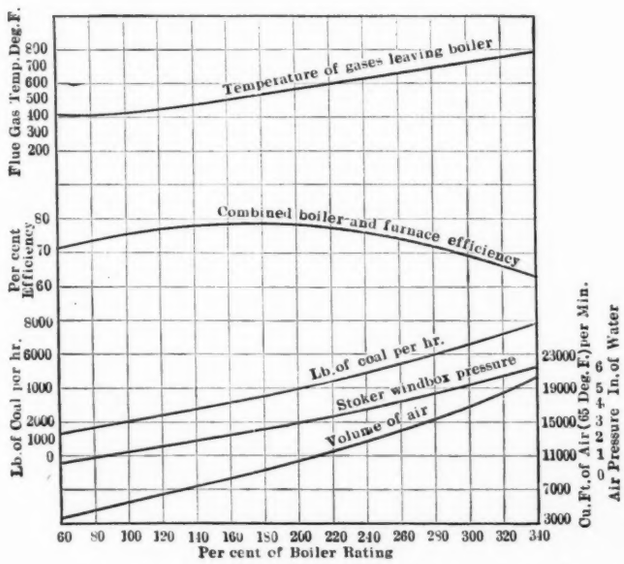
Flue Gas Temp. Deg. F.
Temperature of gases leaving boiler
Per cent Efficiency
Combined boiler and furnace efficiency
Lb. of Coal per hr.
Lb. of coal per hr.
Stoker windbox pressure
Volume of air
Cu. Ft. of Air (65 Deg. F.) per Min.
Air Pressure In. of Water
60 80 100 120 140 160 180 200 220 240 260 280 300 320 340
Per cent of Boiler Rating

FIG. 4. CALCULATED PERFORMANCE CURVES

it was developing 200 per cent of rating, and within four minutes, 300 per cent. A comparison of the calculated performance curves of the new stoker, Fig. 4, with the test curve, Fig. 3, shows results obtained in practice to exceed those theoretically determined.

While designed on the same principle, the single-retort, side-cleaning stoker differs in the location of the dump, which is on the side. It is hand-operated and refuse can either be removed through ash doors in the front or delivered below to a hopper or ash conveyor. The arrangement for admitting air, under control through the tuyères on either side of the retort, produces a high overload capacity on quick demand. The plunger or ram is operated through reduction gears from a shaft below, driven by a small engine or motor.

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Not to be outdone by its neighbors, Czechoslovakia is considering utilization of its water-power resources. A plan has been submitted to the Ministry of Public Works for the construction of a dam which would make possible the development of 250,000 million kilowatt-hours of electricity per year.

## Stopping Losses in a Small Plant

By Arthur W. Drew

My first job after getting out of school was in a candy and cracker factory. A rather unusual place, I must admit, for a fellow who had studied marine engineering for four years. However, at that time jobs were not going begging, and figuring that you have to have a minnow to catch a bass, I took the place. My official title was assistant engineer, but lest such be thought a name of distinction, allow me to explain that "jack-of-all-trades" would have thrown much more light upon the nature of my duties, which ranged all the way from fixing broken candy ladles for the girls to designing new attachments for various candy machines.

The place operated a boiler merely for steam heating and obtained all mechanical power from motors. Did I call that a boiler? Perhaps I had better describe it and allow the reader to draw his own conclusions. It was, then, an apparatus designed to produce steam, of a type known as a locomotive boiler. The conventional brick setting, with rounded arch in the rear, was used, and the duty of the engineer, as nearly as could be figured, was to watch the steam-pressure gage and see that it indicated around 80 lb. Words cannot describe the decrepitude of that outfit. One could go around to the rear and watch the flames down in the furnace through cracks in the arch. Or he could hold a flame at any number of joints where mortar had once been and have it nearly snuffed out.

The delivery system was no better than the production end of the steaming apparatus. One could search in vain for an inch of steam pipe that was insulated;

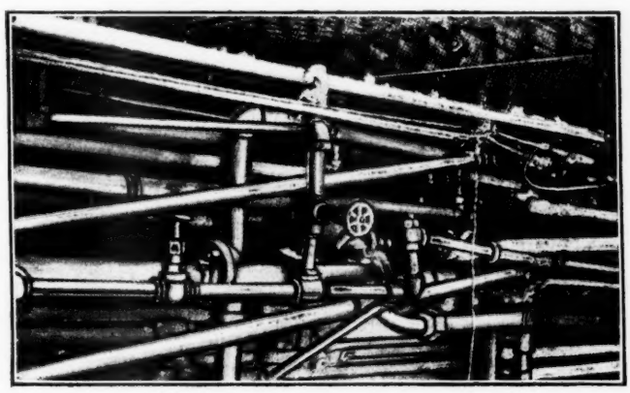

FIG. 1. THE PIPING SYSTEM

and no provision had been made for future installations. For instance, when steam was to be piped to one candy table, a pipe only large enough to take care of that one piece of apparatus would be installed. When another steam pipe in the same vicinity became necessary, another small pipe was tapped in near the boiler. The outcome of this happy-go-lucky policy was, as shown in Fig. 1, a bewildering crisscross of pipes all over the ceiling of the first floor—pipes of various sizes, running in all directions and not a single one of them with an inch of covering.

The chief told me: "Sure, I know those pipes ought to be covered. Told the old man so three or four times, but he merely gives that sheepish nod of his and won't

say nothing. He can go to a warmer climate. I've done all I'm goin' to."

So after failing to get action through him, I decided to cut all red tape and approach the manager himself regarding the chances for sufficient funds to buy some covering. After presenting my case orally with all the eloquence I could muster, he answered as follows: "Well, maybe it ought to be done, but we've got along that way for five years now and I don't feel like spending any more money than I have to. Guess we'll let it rest awhile."

But knowing my stay here would probably be short and realizing the chance to do some conservation work

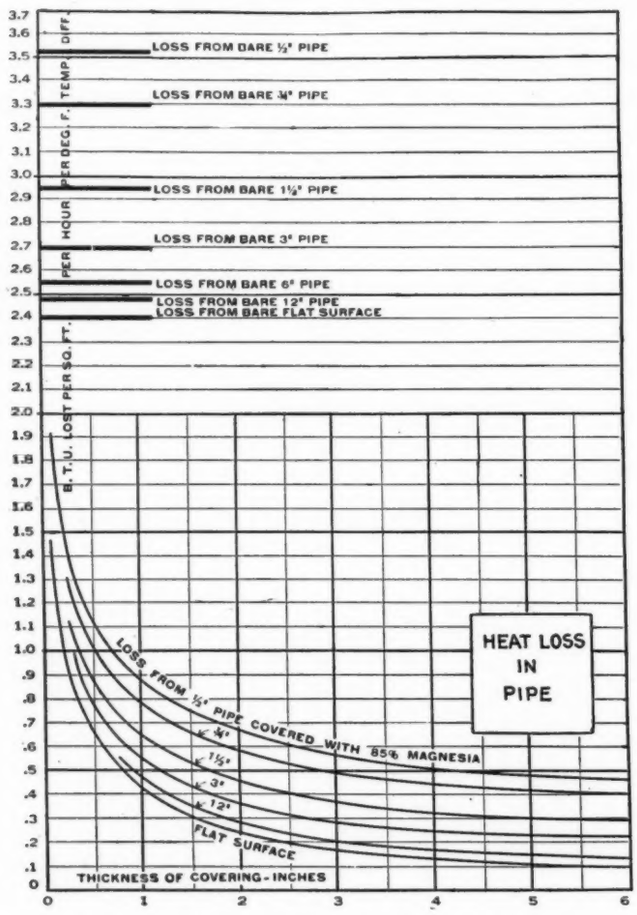
B. T. U. LOST PER SQ. FT. PER HOUR PER DEG. F. TEMP. DIFF.
LOSS FROM BARE ½" PIPE
LOSS FROM BARE ¾" PIPE
LOSS FROM BARE 1¼" PIPE
LOSS FROM BARE 3" PIPE
LOSS FROM BARE 6" PIPE
LOSS FROM BARE 12" PIPE
LOSS FROM BARE FLAT SURFACE
HEAT LOSS IN PIPE
LOSS FROM ½" PIPE COVERED WITH 85% MAGNESIA
¾"
1½"
3"
12"
FLAT SURFACE
THICKNESS OF COVERING - INCHES

FIG. 2. CHART SHOWING LOSS IN BARE AND COVERED PIPE

really worth while, I decided to convince the "old man" by hook or crook. So, after studying his peculiarities for a while, I found out that he was very amenable to the written word. Tell him something orally and it would be forgotten almost as soon as spoken, but write it down in plain black and white and he would usually sit up and take notice.

Trying this tack, I prepared a report making it as technical as possible, using the chart appearing in Fig. 2 and taking care to have my assumptions on the safe side. I set forth, down to the last cent, the exact sum the company was losing, according to my figures, by failing to have its steaming system heat-insulated. Of course my results could not have been exact since it was necessary to assume so many temperature values, but the definite figures seemed to "talk."

Two weeks went by without a word from the office, and having signed up for the job I was after, I began to grow nervous. Finally, the following Monday morning the manager called me into his office. My report was before him. "Now," he began, "I took the trouble to have Mr. Rhodes (a consulting engineer in town) look this over to see if it was all right. He tells me that you are absolutely correct and that the report shows a very commendable spirit. You go ahead and make out your requisition for what you need to cover these pipes and I'll O.K. it."

Well, we lost no time in taking measurements and ordering the material because the old man was known to change his mind at times. It surely was a relief, therefore, to see all the material piled up in the boiler room with nothing to do but get busy and clap it on. Now we had no instruments, not even an oil gage, and the only evidence we had that we were effecting a saving was that presented to the senses. But that evidence was enough. Before we went to work it was customary to keep the valve on the oilburner wide open. The burner was equipped with an automatic regulator designed to close when the safety valve opened at 80 lb. gage. For some reason the regulator never worked nor did it ever need to because it was a very rare thing to see the safety valve blow. The usual pressure was 60 lb. and even lower.

We covered the main lines first and could almost see the old gage creep up for every length of covering we put on. By the time we had 65 ft. of the main 1½-in. line finished, the gage was hovering around 80 and the safety valve was popping a good share of the time. Then we cut down the capacity of the burner and went at it again. Each time we would cover a certain length of pipe we would again have to cut down the burner. Finally, two weeks later, when every steam pipe down to ⅜ in. was under cover, there was a real difference. We could now keep the gage around 80 with the oil valve open between one and two turns. Not only that, but Jimmy, the candymaker, expressed it, "She sure boils like blazes now. We can cook up a batch in half the time."

The foregoing would be unimportant were it unique. But observation has convinced me that it is not. I have seen several small manufacturing plants operating in this haphazard fashion and, taken as a whole the country over, the needless waste of fuel must be enormous. It seems to me that here is a chance for engineers to do a real service. If all will remember that the country must depend on us to conserve its fuel and that managers are not always in a position to judge what is to their company's best interest along this line, we can, by keeping everlastingly at it, make a real showing at fuel saving.

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The resistance or conductivity of electrolyte for lead-acid storage batteries depends upon the proportion in which the pure concentrated acid and distilled water are mixed. Either concentrated acid or distilled water alone is of very high resistance—in fact, is an insulator rather than a conductor. Any combination of the two has a lower resistance or, otherwise expressed, a higher conductivity than either alone. The highest conductivity occurs when the specific gravity of the mixture is 1.260. It is for this reason that the specific gravity of commercial types of batteries is kept in the neighborhood of 1.2.

# EDITORIALS

## Power-Plant Accounts

MANY persons still take pride in making a mystery of their business or profession. This attitude betrays a smallness of mind that is rapidly disappearing under modern methods of conducting business. Concerns in similar lines of manufacture today exchange information that in previous times was most zealously guarded. The up-to-date physician no longer doses patients with imposing prescriptions, nor hesitates to acknowledge his inability to make a diagnosis in unusual cases. In fact, it is now recognized that the more competent the individual, the greater is his frankness in communicating the "secrets" of his profession and in confessing his ignorance in a given case.

Often the secrecy of a business lies in the language pertaining to it, and anyone taking the trouble to study the meaning of the terms used would immediately be initiated into the apparent mysteries thereof. When the terms introduce entirely new conceptions, it may require considerable study to understand their significance. Thus, to define a volt or an ampere to a person unversed in electricity would do little toward improving his conception of the terms, and it would take a period of study to make them clear to him. If, however, the same person be told that a compression bibb is what he has always recognized as a "faucet," any mystery that may have attached to the former term will immediately disappear, since he is already familiar with the contrivance to which it applies.

Following out the foregoing analogy, it will be found that the apparent mysteriousness of bookkeeping or accounting lies chiefly in the language in which it is conducted. Accounting is merely a method of recording transactions as they occur. All of us do some manner of accounting. If we write down in a book what expenditures we make from day to day, we are doing accounting. If we make a record of the coal used daily or the number of kilowatt-hours generated, we are keeping accounts. Accounting is not confined merely to money transactions, being equally applicable to dealings in commodities or labor or any other thing of which record is to be kept. Many a person who would disclaim any ability as an accountant, has devised means of keeping track of the cost of production under his supervision that provide him with all the essential information required as surely and accurately as any system that might have been installed by an expert accountant. And why? Merely because he has followed his common sense in gathering the information he found he needed, and keeping it in such shape as would tell him what he wished to know whenever he wanted to know it. The form of his entries and his arrangement of them might not be those that would be used by a professional accountant, but he would get the same results.

The point to be constantly borne in mind in devising any system of accounts, is that it is the results of the accounting that are of value, not the system by which they are obtained; the latter is only the means toward an end. Hence, it will generally pay one to investigate other systems before deciding on one of his own. Since there are concerns that have made a business of studying such systems, it is safe to assume that any standard practice that has been established is such as eliminates many elements that are likely to make the self-developed system more cumbersome than necessary and provides others that safeguard it against inaccuracies not apparent to the unwary. Moreover, many conceptions regarding the interrelation of the component parts of a system, such as are not ordinarily recognized, may be brought home to one upon studying the principles that underlie it.

That the determination of costs in the power plant is a necessity is no longer a matter for debate. The generation of power must eventually be put on the same basis as the manufacture of any other product. In an attempt to present to its readers the principles of power-cost accounting, *Power* has in preparation a series of articles—the first of which appears in this issue—that are designed to cover the various phases of the subject in such a way as will enable the operating man to apply them to his particular problem when the need arises.

## A Blind Draftsman

TO MAKE designs and put them on paper without the use of sight inspires not only amazement, but the most profound respect for anyone having the determination to do it. Such a man was the late William D. Forbes, an inventor and engineer whom many readers will recall as a frequent contributor to *Power* and the *American Machinist*. Before his death he prepared a description of his method of developing designs and of making drawings, unaided, on the typewriter. This was the basis of an article appearing recently in the *American Machinist*, and recalled to attention the triumph of the man's indomitable will over an affliction that usually brings only despair.

Soon after he became blind, an idea for a machine part came to his constantly active mind, and he felt the same urge to give it expression that distinguishes an artist from a sign painter. So he began dictating to his daughter, who was able not only to typewrite his manuscripts, but to make drawings for him as well. Feeling the need of closer contact with his work, however, he taught himself to typewrite, using, of course, the well-known touch system. This naturally led to the wish to use the same means for making his drawings, and by patient practice he was able to do just that.

The principle of his method was simple, yet its application must have been difficult in making any but the most elementary designs. First it was necessary to visualize completely and definitely the part that he was to draw. This, in itself, is more than most draftsmen can do, but his troubles began there. He used a typewriter fitted with a back-spacer and a tabulating pencil arm so arranged that a line would be made on the paper by turning the roller or by moving the car-

riage horizontally. Starting with some main point or corner of the object to be drawn, he would turn the roller so many clicks for a vertical line, move the carriage along so many spaces for a horizontal line, and then repeat, this way and that, returning finally to the starting point. He had to remember the exact number of spaces moved each time and whether each line was horizontal or vertical, and in what direction.

"It was a simple matter," he wrote, to put reference letters, indicating the different parts, in their proper places. All that was necessary was to keep in mind the number of spaces used for every line drawn. Simple, perhaps, in comparison with making the drawing itself!

"Concentration, memory and patience," he concluded, "are three attributes needed by a blind person to make sketches, or in fact to do anything. To my mind, if these same qualities were more seriously studied and worked by the people who have eyes, they would find that their daily work would soon become easier and would be far better done."

Prompt agreement will meet that statement, but is there not a stronger lesson to be learned from this man's life than merely the excellence of these three mechanical attributes? It was not by these alone that Mr. Forbes was able to keep on with his work and to retain his warm-hearted cheerfulness of spirit. It was not by such means that Edison, stone deaf, devised an instrument that reproduces sound with marvelous fidelity. Fundamentally, it was grit.

We may learn from the life of Mr. Forbes, and from the success of others similarly afflicted, that "Concentration, memory and patience" are good things to have. Of far greater value, however, will be the realization that most of us are pretty well off, after all, and that the little obstacles in our way are there to be overcome. Let the pessimist and the grumbler hide themselves for shame, and let us tackle petty difficulties in a spirit of thankfulness that they are no greater.

## The A. S. M. E. Code in the Oil Fields

THE fight between the oil-country interests and the proponents of the boiler code of the American Society of Mechanical Engineers in Oklahoma seems in a fair way to be settled peacefully, if somewhat tardily. A conference between representatives of the different interests involved was held in Tulsa recently, and reports of the meeting indicate that a great deal of misunderstanding was cleared up, and that a reasonable agreement was determined upon for the inspection and regulation of oil-country boilers.

Among those present at the meeting were: Mr. Murphy, assistant labor commissioner of Oklahoma; Mr. Land, state boiler inspector; Mr. Gorton, chairman of the American Uniform Boiler Law Society; Mr. Moore, the official representative of the Boiler Code Committee, and Mr. Porter, of the Gulf Oil Corporation, representing the A. S. M. E.

It was agreed that oil-country boilers should be duly inspected, and that reasonable restrictions should be placed upon their operation, but, on the other hand, that the Code should not apply to boilers already built or building, and that such boilers should be regulated according to the Department of Labor so as not to work a hardship upon the oil industry. It was determined also that new boilers, whether for oil-country use or otherwise, must, after a certain date, be built according to the Code, but no boilers already built are to be affected.

A large amount of good paper and ink has been used in telling how the A. S. M. E. Code would scrap all the boilers in the oil fields and would force the owners to pay out thousands of dollars for new boilers, to put highly skilled mechanics in charge of them, and much other twaddle. Ill-advised propaganda of this nature has delayed settlement of the matter too long already, and it is well that the air is clearing and that the so-called opposing interests are coming to realize that, after all, there is nothing to fight about. The object is simply that new boilers shall, after the date to be agreed upon, be built to a definite standard of safe construction and that existing boilers, until they have outlived their period of usefulness, shall be operated as safely as is reasonably and practically possible.

## A New Phase of German Efficiency

STANDARDIZATION has become a national craze in Germany in somewhat the same way as efficiency has in this country, according to the comments of engineers, scientists and manufacturers who have been to Europe since the war. The efficiency of German endeavor, in whatever line applied, is a matter of history, but the standardization idea did not develop into its full intensity until the war period. Now the fight for the world's trade is on, and Germany has cleverly recognized the fact that the country offering a wide choice of products, all of each kind being interchangeable, will have on that account a marked advantage over its competitors.

A national realization of the need for rebuilding its export trade, and of the part that standardization would play in securing it, has resulted in the formation of a national organization that is supported by the country's leading industrial and technical associations. It is analogous to our own American Engineering Standards Committee, but is apparently far more active, not only because of the present situation, but also, in all probability, because of the traditional German tendency toward submission to centralized authority.

England, too, is paying attention to the problem, though not with the same intensity that Germany is displaying. Perhaps some further effort along this line would be advisable in this country, in view of the increasing activity of America in international trade. Even for domestic reasons further standardization would in many cases be desirable, and would go a long way toward the elimination of waste.

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The furnace of a boiler is simply a generator of heat units and gas. It makes no difference whether the fuel be coal, coke, oil or gas, the function of the furnace is the same. It is to produce intensely heated gases that conduct the heat to the transmitting surfaces. Indeed, it is essential for the sake of analysis to detach furnace operation from all other operations of the boiler. Think of it as a generator of mixed heat and products of combustion. Think of the concentration of heat that is desired and the composition of products that is most effective. Then will the principles of efficient operation become clear. Then and then only will the problem of heat absorption in the boiler tubes start with the most favorable conditions for efficient work in that stage of the process.

# CORRESPONDENCE

## Pulverized Coal vs. Stoker Firing

I recently read F. P. Coffin's article in the July 12 issue of *Power* entitled "Pulverized Coal Versus Stoker Firing," in which he refers to the use of the forced-draft traveling-grate stoker and states that this type of stoker can burn only one size of anthracite efficiently; namely, No. 3 buckwheat. This is not correct.

The forced-draft traveling-grate stoker, as represented by the Coxe stoker, will burn both No. 1 and No. 2 buckwheat as well as No. 3, and with even better efficiency. The furnace design would be somewhat different from No. 1 and No. 2 buckwheat with No. 3. This stoker will also burn No. 4 buckwheat, but not with the same efficiency. At the same combustion rates the efficiency when burning No. 4 buckwheat will be about 10 to 15 per cent lower than with No. 3 buckwheat.

This stoker will also burn silt or run-of-bank coal, provided there is not much large coal in it. The efficiency will be still lower than with No. 4 buckwheat, probably between 40 and 50 per cent at corresponding combustion rates.

Pulverized anthracite is at a tremendous disadvantage in comparison with stoker firing on account of the high cost of preparation. The possibility of using pulverized anthracite economically depends primarily on the cost of the coal. At this time No. 4 buckwheat and lower grades are so cheap as compared with No. 3, that the total cost of burning them in pulverized form is undoubtedly prohibitive.

JOHN VAN BRUNT, Chief Engineer,
Combustion Engineering Corporation.
New York City.

## Proposed Code for Welded Pressure Vessels

S. W. Miller's proposed code for welded pressure vessels, page 192 of the Aug. 2 issue of *Power*, is interesting to me, inasmuch as I have tried to use welded pressure vessels in a number of states. I find that state officials and sometimes city offiicals are "afraid" to allow the use of such vessels because they are something comparatively new. Even though it is proposed to test the vessels at a hydraulic pressure of 500 lb. per sq.in., whereas in actual use the pressure would seldom if ever go as high as 180 lb., the officials shake their heads and seem to feel that there is altogether too great a "risk" involved.

It is true that there is a so-called "personal factor" that must be given consideration in the welding of joints. But so is there a personal factor in the riveting of joints. I know of instances where inspectors have compelled builders to re-rivet joints because one rivet was found to be imperfect. It is the right thing to do. In welding, the same precautions can be taken now that methods are being devised for cutting out test sections to be given actual strength tests to destruction.

Manufacturers of welding apparatus are themselves considerably to blame for not doing more real comparative testing and for not giving their methods more publicity. I have written many letters to manufacturers asking for "test data," particularly on comparative strengths of riveted vessels and welded vessels tested to destruction. The nearest approach to an answer was made by one manufacturer who stated that "a boiler insurance company has made some tests to destruction and we understand that the results are favorable to welded pressure vessels, but these data are not available to us." Most of the manufacturers sent salesmen in an effort to sell me welding apparatus, and we talked and talked and talked, but I couldn't get any real information out of them. Some of them said that they had the data I wanted "at the office and would send it," but up to the present time I have not received it.

I believe there is a great need for some comparative tests before a real code can be framed. It should be shown and proved in these tests that the personal factor is not so important after all, now that more is known about conducting tests on welded vessels.

It is not clear in my mind just what organization Mr. Miller proposes to put behind the code. The A. S. M. E. or the American Society for Testing Materials? He mentions the latter. I understand that the Boiler Code Committee of the A. S. M. E. has been endeavoring to get reliable information on welded joints and welded boilers and that they are still groping in the dark.

Mr. Miller says, "First, the making of welded pressure vessels, so that the plate will always be weaker than the weld." This sounds as though the plates may be made weaker than they were in the first place. I think it would be more advantageous to the booster of the welded pressure vessels to say, "The making of welded pressure vessels, so that the joint will always be stronger than the plate." In other words call them "joints of more than 100 per cent strength."

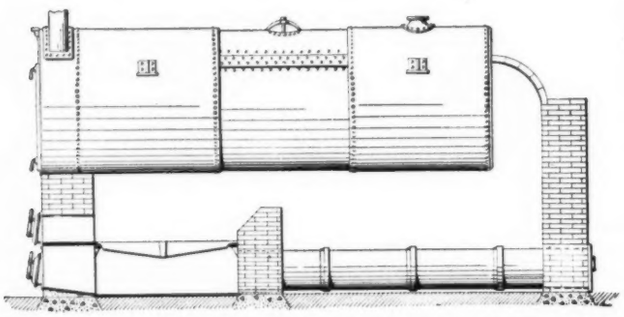
The question also arises, Why limit the thickness of plate to $\frac{5}{8}$ in.? Would not a $\frac{3}{4}$-in. plate be safer than a $\frac{5}{8}$-in. plate? Would not a 1-in. plate be safer than a $\frac{3}{4}$-in. plate? It is assumed that welding is properly done in every case. If the thickness is limited to $\frac{5}{8}$ in., might there not be the danger of somebody trying to "get by" with a $\frac{5}{8}$-in. plate, whereas a $\frac{3}{4}$-in. plate should be used?

Newark, N. J. W. F. SCHAPHORST.

## Preheating Air to Boiler Furnace

In a steam plant containing two 18-ft. x 66-in. horizontal return-tubular boilers which were hand-fired with nut-and-slack coal of fairly good quality, the engineer figured that he could improve combustion by heating the air before admitting it to the ashpit. His way of doing this is shown in the sketch.

Two ducts, made by joining together sections of 10-in. circular tiling, were constructed longitudinally through



TILE DUCTS RUNNING THROUGH COMBUSTION CHAMBER

the combustion chamber of one of the settings. These ducts led from 10-in. circular openings in the rear wall to similar openings in the bridge wall. The admission of air through the ducts was controlled by means of sliding gates or dampers attached to the inlet orifices in the rear wall. The ashpit doors were, of course, kept closed.

It is not on record that the use of this device improved the fuel economy of the plant. It did, however, seem to aid materially in eliminating smoke. This was probably due to the fact that the air currents being admitted through the bridge wall, curled up immediately upon entering the ashpit and delivered an ample supply of oxygen to the fuel at the back end of the furnace.

One day while the boiler with the rear-end air intakes was in service, the draft through the furnace suddenly ceased. It was evident that something had happened to the intake ducts. The other boiler was fired up and put in service. When the fire in the "lame" furnace was drawn and the setting had cooled down, it was discovered that one of the sections of tiling had collapsed, thus shunting the incoming air current directly into the combustion chamber.

A. J. DIXON.

St. Louis, Mo.

## Worm-Gear Oiling Device

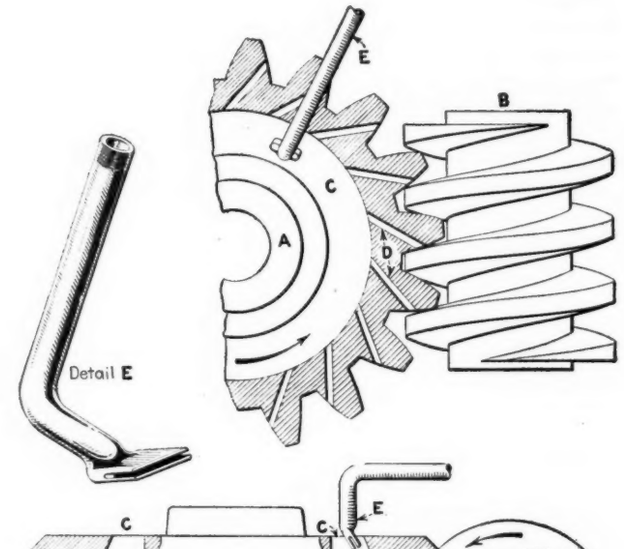
On a certain design of horizontal turbine the governor and oil pump are driven by a worm gear. Some of these give trouble from wearing, which causes the governor to vibrate badly, depending on the amount of wear. My latest experience was with three 6,000-kw. units. The new gears did not run very long before they began to wear and the governor to vibrate. I tried changing the position of the gears, raising the worm gear slightly above the center of the worm and again slightly below the center, but it did no good. My opinion is that the turbine oil used to lubricate these machines, while it is good oil for the bearings and hydraulic gear, is not heavy enough for the worm gear, as it has to run up around 150 deg., which is the best temperature for the bearings.

These gears, however, are so placed that they drain directly into the pumps, so that no other oil could be used on the gears alone and not get mixed up in the turbine oil, whereas the gear oil should have been of a different grade.

The sketch shows a plan I worked out, which proved successful on the machines mentioned. In the bronze worm gear *A* on the governor and pump shaft an oil groove *C* is turned, $\frac{1}{4}$ in. deep by $\frac{5}{16}$ in. wide at the top; the side of the groove next to the teeth of the gear is cut wider and at an angle so as to form an oil pocket. This groove is on the top side of the gear. From the side of the tooth that comes in contact with the tooth of the worm $\frac{3}{8}$ in. from the top and about the center of the depth of the tooth, a $\frac{1}{8}$-in. hole *D* was drilled in every tooth and into the groove *C* on the worm gear as shown.

An oil groove *F* was cut with a small round-nose or diamond-point chisel for about $\frac{3}{4}$ in. down the face of the tooth and slanting toward the bottom of the tooth. A nozzle *E* of $\frac{1}{8}$-in. pipe discharged into the groove *C*, the other end of which was connected to the bearing-oil feed.

The nozzle should feed into the groove slightly before the point of contact of the teeth of the two gears. The groove and holes act on the principle of a centrifugal




HOW THE OIL GROOVES AND HOLE WERE CUT IN THE WORM GEAR

pump and force the oil under the gear teeth, where it should be.

In the old case, where the oil poured down on top of the gear only it was mostly shaved off by the sharp edges of the teeth before it got to the surface of the teeth. The new arrangement worked out successfully, and I think it worth trying should anyone else have the same trouble.

L. W. KELLY.

Fairhaven, Mass.

## Generator Operating Temperatures

In connection with my article on "Generator Operating Temperatures" in the Aug. 30, 1921, issue, my attention has been called to the temperature detectors shown in Figs. 4 and 5. From these figures the impression may be derived that the detector element is bulk, covering practically the whole slot width. This, of course, is not the case. The detector element of either the resistance or thermocouple type is narrow as compared with the width of the slot and is also made as thin as practicable. Where detectors are placed between upper and lower coil sides, as in Fig. 4, the detector is located in the center of the slot space so as to be removed as far as possible from the iron on each side.

S. H. MORTENSEN, Elec. Eng.,
Allis-Chalmers Manufacturing Co.
Milwaukee, Wis.

## A Novel Oil Filter

With the development of the filter press and the centrifuge, we are credulous and have the idea that any solution containing substances of two different densities can be separated. The separation of two liquids, or a solid in solution in a liquid, are problems most commonly solved by the centrifuge.

It often happens that the solid in solution in a liquid is of such a nature that a centrifuge will have no effect upon it. Filtering is resorted to, and in some cases even the ordinary brands of filters cannot accomplish the desired results.

In some industries light oils are used for various purposes such as burnishing, maintaining even temperatures and other light work. Dust accumulates in these oils, and soon they become unfit for use unless the dust and dirt can be removed.

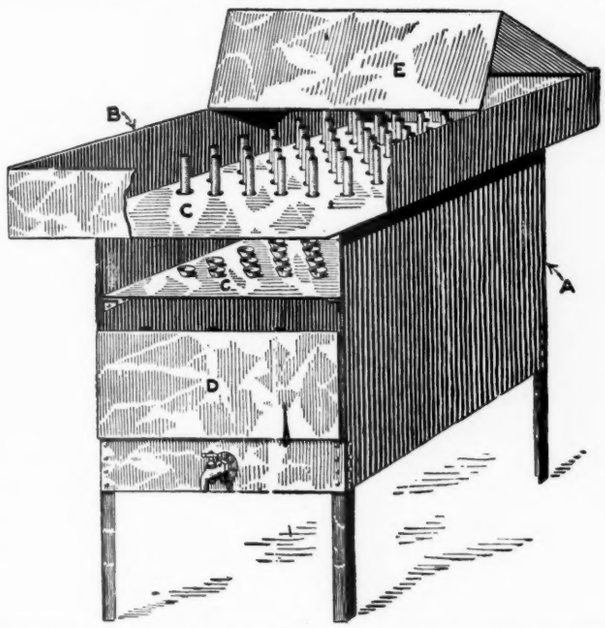
One case, particularly, in which I was interested, was a light spindle oil used in large quantities. Dust, dirt from the hands of the operators and fine steel chips got into this oil. The chips were so fine that they were held in suspension and would not settle out, even in a month's time. The oil was valuable, and to throw it away was a waste. Some of it was used to slush machine parts to prevent rusting while in the storerooms, but as several barrels accumulated every week, this did not make much impression on the supply. The only thing to do with the remainder was to pay some one to cart it away, which was expensive, and it seemed all wrong to destroy the oil simply because it contained some fine chips, dust and dirt.

Several of the commercial brands of filters were tried out in an effort to save the good oil, but the suspended particles were so fine that they came through the filter cloths, and if the oil was used after this filtering, it would not burnish at all, but scratch instead. So this kind of filtering was useless. Centrifugaling was tried, but with no better success.

The following idea was put into execution with quite satisfactory results. It was really an adaptation of an old principle, but it seemed to be the only thing that would answer the purpose.

Anyone who has had anything to do with chemical laboratory work will know the action of ordinary filter paper in separating the precipitate from a solution. In reality the dust and dirt suspended in the oil was a fine precipitate and would not be caught by the regulation filter cloths. But when put in a laboratory filter paper it was found that the fine particles were left on the paper, while clean, clear oil passed through. At first it was thought that it would be a very slow process to filter three or four barrels of this material through small laboratory papers. But this was the principle that was put in operation and it worked to perfection.

The apparatus was made similar to that shown in the figure. The retainer *A* was made of angle irons and sheet metal and was high enough to permit a bucket to be placed under the clean-oil drain cock. This tank was about 24 x 24 in. and 26 in. deep. A door *D* was put in the front to allow entrance into the slide *C*, which contained the filter papers. About six inches from the top three angle irons were riveted to the sides




FILTER IN WHICH FILTER PAPER WAS THE MEDIUM

and end, for the purpose of supporting the slide containing the filter papers. The slide *C* was of sheet metal and contained 36 holes to receive and support the papers. The papers were about 9.5 in. in diameter and were of the cheapest kind that could be purchased. The door *D* was always kept closed except when changing papers.

The upper tank *B* was approximately 36 x 36 in. and 12 in. deep. Into this was put the dirty oil. In the bottom of this tank 36 holes were drilled to correspond with the filter papers below. Small pipes, about 6 in. high, were soldered to the bottom of the tank above the holes, as shown. The upper reservoir holds about 33 gallons.

The next problem was to get the oil to feed automatically into the papers, and this was accomplished by the use of wicks. It required considerable experimenting to determine the right number of wicks to use in order to feed oil to the filter papers in an amount sufficient to keep the papers filled to the proper height. But this is a simple matter after all, and when the wicks are in place, it is only necessary to pour in the dirty oil and start the papers by filling them to the right level and let it go. The filter papers have to be changed about every seven or ten days. This simple filter, which is inexpensive, has an estimated capacity of about four and one-half to five barrels per week.

Germantown, Pa. ARTHUR L. COLLINS.

## Mr. Ford and His Muscle Shoals Proposition

The recent offer of Henry Ford to take over Government property at Muscle Shoals on the Tennessee River is so important that I take the liberty of pointing out certain essential facts.

The first part of the Ford offer is to lease the Wilson Dam and Dam No. 3 for one hundred years, with indefinite renewals, provided the Government will complete them and install machinery to produce 850,000 hp. Mr. Ford offers to pay 6 per cent on the 28 million dollars which he estimates will be necessary to complete this work, or 3⅛ per cent on 48 million dollars, Mr. Ford's own estimate of the whole Government investment in dams, locks and power houses. Even if we add all other annual payments (the so-called amortization payments and payments for the repair, maintenance and operation of dams, gates and locks), the total would be equivalent to interest at the rate of only 3⅝ per cent. Mr. Ford offers also to give the Government 300 hp. to operate the locks.

Note that for the waterpower itself Mr. Ford would pay nothing, and that he would be free from all taxes on the property. Other lessees of water-power rights from the Government not only bear the total cost of building their own dams and power houses and pay taxes on them, but they also pay for the water power in addition. The Ford offer is like offering a man 3⅛ per cent on the cost of his factory as rent, and then asking him to throw in a coal mine to supply fuel for the boilers for nothing.

There is no allowance for depreciation, and the Government would beyond question have to pay the cost of injury to the dams or locks from floods or other causes. Moreover, there is nothing in the offer to indicate that the Government, in order to protect its own property, would not have to bear the expense of replacing enormously costly machinery when it had been worn out in Mr. Ford's service.

The second part of the Ford offer is to buy Nitrate Plant No. 1, which cost the Government in round numbers 13 million dollars, Nitrate Plant No. 2, which cost the Government in round numbers 70 million dollars, and other property which brings the total cost to 85 million dollars, and to pay 5 million dollars for it all. The property for which this offer is made includes steam machinery to produce 160,000 hp., which alone is worth far more than Mr. Ford's offer for the whole. In addition, the Government is to buy from the Alabama Power Co. the land on which certain of the foregoing structures were built, and turn that over to Mr. Ford also.

In return for the lease, for the purchased property, and for the water power without charge, Mr. Ford offers in addition to the payments mentioned to do three principal things:

First, "to maintain Nitrate Plant No. 2 ready to be operated . . . in time of war for the production of explosives," and in the event of war to turn it over to the Government for that purpose.

Second, "to operate Nitrate Plant No. 2 to approximate present capacity in the production of nitrogen and other fertilizer compounds," and in this business to limit his net profit from the manufacture and sale of fertilizer products to 8 per cent.

Third, the offer as written suggests producing, but contains no direct proposal to produce, fertilizer for the benefit of American farmers. That could, of course, be corrected in the final contract, for I have no doubt that Mr. Ford desired to make fertilizer at a total net profit of 8 per cent. Nitrate Plant No. 2, however, is not adapted to making fertilizer, but only cyanamide, one of several materials used for the production of fertilizer, and not one of the best at that.

The fact is that the Ford offer is not mainly a fertilizer proposition. It is seven parts water power to one part fertilizer, even if the fertilizer part should work out. For, if Nitrate Plant No. 2 were to be permanently employed in the manufacture of fertilizer it would consume but 100,000 hp. out of the 850,000 installation. This is the heart of the whole matter.

As a water-power proposition, the Ford offer is in every important point directly contrary to the Roosevelt water-power policy, which after 15 years of struggle was finally enacted into law last year. The Roosevelt policy provides that all water-power leases shall be limited to fifty years. The Ford offer asks for 100 years with indefinite renewals. The Roosevelt policy provides for return of the Government works at the end of fifty years. The Ford offer provides for indefinite private possession of the Government works. The Roosevelt policy provides for regulation of the price to the power consumer. The Ford offer, so far as the United States is concerned, provides no check on what the power consumer must pay. The Roosevelt policy provides that public water power taken for profit shall make a return to the public. The Ford offer asks for many hundred thousand horsepower for nothing.

The amount of power Mr. Ford could develop, under his offer, is greater by half than all that is now being developed at Niagara Falls. If Mr. Ford were to pay for it at the rates charged by the Government to other companies that build their own works, as Mr. Ford would not, it would cost him about $150,000 a year.

Beyond question Nitrate Plant No. 2 ought to be maintained in condition for producing explosives in case of war. Most certainly it ought to be used for making fertilizer for American farmers. The wisdom of developing the water power on the Tennessee and its tributaries is beyond question. But all these things can be done with fairness to the public.

I do not believe that Mr. Ford's offer should be summarily rejected. I do believe that it should be changed: First, to make it fit the Roosevelt water-power conservation policy, now the law of the land; second, to make it pay for the property of the people something approaching what that property is really worth, and third, to make what it offers the farmers clear beyond doubt.

It is said that certain Wall Street magnates who hate Mr. Ford are anxious that his offer be rejected. What these men think about Mr. Ford and his offer is surely no reason for giving him public property of enormous value for a consideration wholly inadequate and on terms utterly unfair to the public.

I should be glad to see Mr. Ford make money, and plenty of money, out of taking over the property of the people as he proposed to do, but not such perpetual and gigantic profits as his offer would assure. It is fair to consider the public also, and to remember that all the annual payments Mr. Ford offers to make would amount to only one-third of the yearly taxation necessary to meet the interest charge (at the Liberty Loan rate of 4¼ per cent) on the Government's net investment in the property he proposed to take over, and that he would get the waterpower for nothing.

Philadelphia, Pa. GIFFORD PINCHOT.

# INQUIRIES OF GENERAL INTEREST

**Rotative Speed of Corliss Engines**—Why are not Corliss engines run at higher speeds than 125 to 150 r.p.m.? C. S.

The complicated valve gear and releasing mechanism on Corliss engines make it necessary to run them at relatively low speeds for the various parts to adjust themselves and for the dash-pot pistons to work properly. In order to maintain a proper piston speed with the slow rate of rotation, the cylinder is made longer in proportion to its diameter.

**Cushioning of Piston of Duplex Pump**—How is the piston of a duplex steam pump prevented from striking the heads of the cylinder at the ends of the stroke? R. C.

At each end of the steam cylinder there are two ports. The outer port acts as the steam admission port and terminates at the end of the cylinder so as to guide the incoming steam into the clearance space behind the piston, while the other port, a short distance from the head, acts as an exhaust port. The piston, when near the end of a stroke, covers the exhaust port, and any steam then remaining in the end of the cylinder is entrapped between the piston and cylinder head and, becoming compressed, acts like a cushion in overcoming the momentum of the piston and thus prevents the piston from striking the head of the cylinder.

**Effect of Cylinder Oil or Black Oil in Boiler**—What trouble if any is likely to result from feeding cylinder oil or black oil into a horizontal return-tubular boiler to prevent foaming? F. G. H.

By feeding cylinder oil or black oil to a boiler the volatile part of the oil will be driven off with the steam and be very likely to cause leaky joints in the boiler and piping, especially where there are rubber gaskets. The heavier ingredients of the oil will accumulate on the bottom of the boiler, first forming a sludge which soon becomes converted into a hard mass that will prevent the water of the boiler from keeping the shell cool. The shell thus becoming overheated, a bag is formed and the material becomes burnt. Oil in a boiler is not of benefit in preventing foaming; in fact its presence usually promotes foaming.

**Caking of Soot from Use of Steam-Tube Cleaner**—In using a steam-tube cleaner for tubes of a return-tubular boiler, we are troubled by the steam converting the soot into a paste that quickly becomes baked hard and cannot be removed with a flue brush or scraper. Could not the difficulty be overcome by blowing out the tubes with compressed air? C. B. C.

The trouble could be obviated by using compressed air provided a sufficiently large supply of dry air at high pressure would be available for the operation. Caking of the soot in the tubes results from moisture that is driven out of the fuel or discharged from the steam tube cleaner, and there will be less of this trouble from the steam tube cleaner if, before use, any water gathered in the hose or other connections is thoroughly blown out and the cleaner is supplied with dry steam.

**Lightning Protection for Grounded Neutrals**—A single-phase lighting transformer is connected between one phase wire and the neutral of an overhead four-wire three-phase 4,000-volt distributing system, fed directly from three-phase 4,000-volt star-connected generators with grounded neutral, the neutral wire of the system being connected to that of the generators. In installing protective apparatus for the transformer and the generating station, should lightning arresters be connected on the neutral as well as on each one of the phase wires? R. A. D.

It is not necessary to provide a lightning arrester for the protection of a grounded neutral. The object of lightning arresters is to act as safety valves, to connect the different conductors to the ground whenever the tension rises above a certain value, and so allow the accumulated charge to flow off to the ground through the arrester rather than through the insulation of the machines or over or through the line insulators. Since the neutral wire is permanently connected to the ground, it needs no lightning arrester. When the neutral is not grounded, it should be equipped with an arrester.

**Sodium Chloride Brine**—If the temperature carried is above 8 deg. F., is sodium chloride advisable in view of the lower cost compared to calcium chloride? Will it cause increased corrosion? P. V. A.

Ordinarily, sodium chloride brine of 25 per cent strength should be satisfactory. However, it has a characteristic which often prevents its successful use for low temperatures. If a 20 per cent solution is cooled to 15 deg. F., the salt begins to settle out and will continue to do so until 6 deg. F. is reached, whereupon the mass will solidify, becoming a cryo-hydrate. The mass is made up of frozen water and salt crystals. Calcium chloride will do likewise, but at a much lower temperature. If the brine solution is not uniform at all points in the system, the strength at some point may be so low as to cause the freezing at fairly high temperatures. No reason can be seen why the addition of sodium chloride to the calcium brine should cause corrosion.

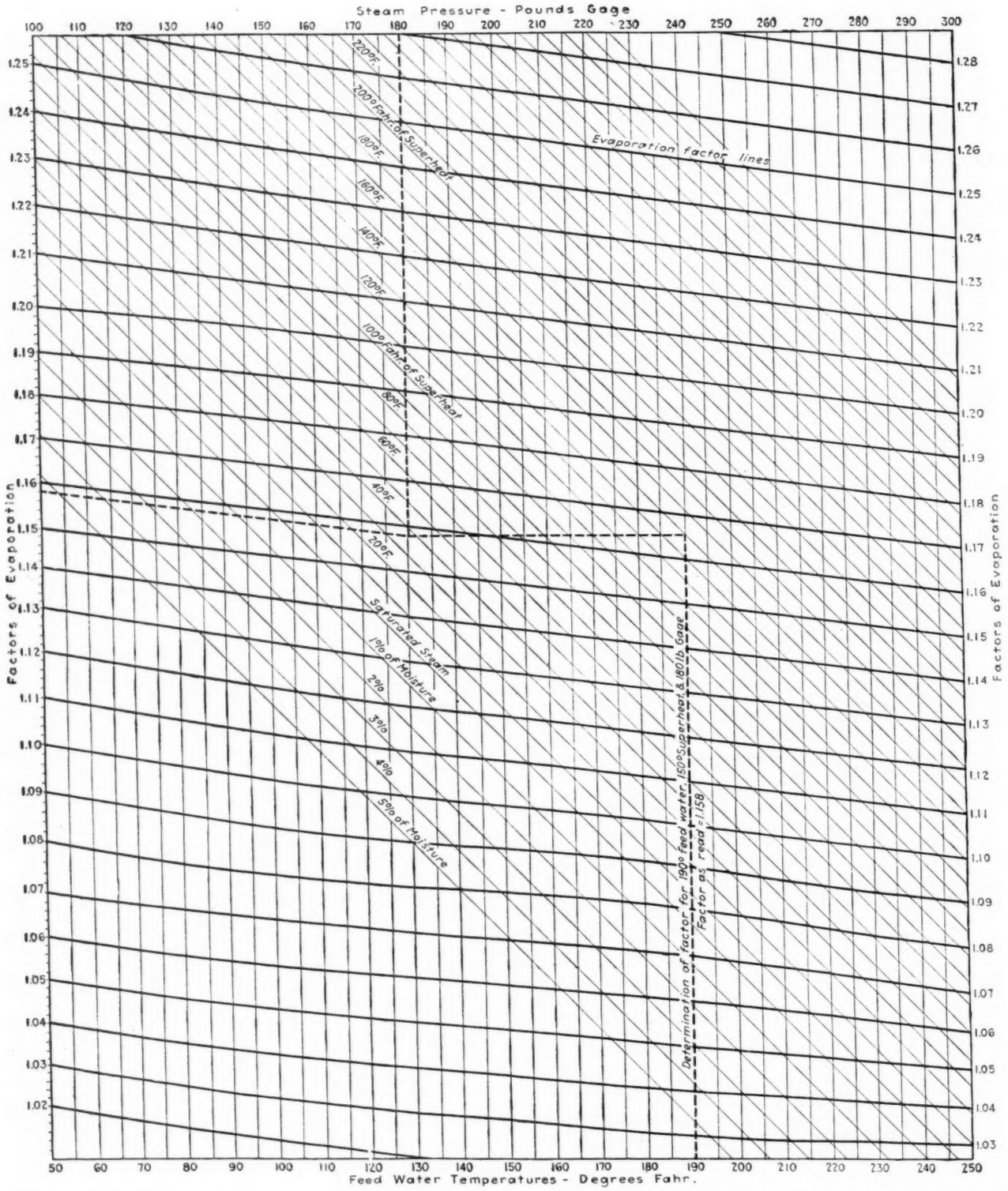
**Driving Belted Generators Belt Over Belt**—As a temporary expedient, during installation of a new electric generator, it is proposed that we could drive two belted generators from the same engine wheel by separate belts having one belt traveling over and around the other. Would that method be practical? E. T. L.

In the early days of electric lighting this method of driving more than one belted generator from the same engine wheel was quite common. The drive is practical, provided the belts do not come in contact with each other except in bending around the engine pulley. With proper alignment of crowned pulleys and good belts, made up endless and kept tight, there is no more danger than from use of a single belt. However, when one of the belts sways from side to side from being crooked, too slack or not uniform in thickness, or when the pulleys are not in good alignment, it is likely to run completely off of the pulleys and usually the other belt will be left intact.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

# Factor of Evaporation Chart

By M. W. LEONARD




While a large number of boiler tests are being conducted, the time spent in calculating the factor of evaporation for the several conditions of steam superheat and feed-water temperature becomes entirely too great. To reduce the labor the testing laboratory of the Public Service Company of New Jersey prepared a chart by which the factor may be read direct.

The chart is entered at the bottom at the point corresponding to the feed-water temperature, say 190 deg. F. This line is followed vertically until it intercepts the diagonal superheat or moisture line representing the steam condition. From this point the pencil is moved horizontally until it intercepts the vertical line representing the steam pressure. From this junction the path parallels the adjacent factor of evaporation line to the edge of the chart when the factor of evaporation for the given conditions may be read direct. The chart is accurate and has been of great assistance to the Public Service Company. Marks and Davis steam tables were used in the computations. The chart should be tacked on a drawing board.

# Washington News

## Recent Decisions of the Power Commission—Dr. Smith Describes British Coal-Mining Conditions—Small Concerns May Be Exempt from Census

By Paul Wooton
Washington Correspondent

A preliminary permit to extend for two years has been granted by the Federal Power Commission to the Kelly Mines Company, of Seattle, Washington (Project No. 207). The project is on the Little Susitna River and Fishhook Creek in the Knik Precinct of Alaska. It involves the construction of a diversion dam on Fishhook Creek and the erection of a power house. A second diversion dam is to be constructed on the Little Susitna along with a power house and a water conduit. The company is required to make stream-flow measurements and to "sink such test pits or make such borings or other foundation explorations as will make available sufficient information relating to the character of foundations for each of the dams and power houses to permit of the designing of such dams and power houses in accordance with good engineering practice and the checking of their safety, adequacy and desirability in the development of the resources involved."

A license has been granted by the commission to the Alaskan-American Paper Corporation (Project No. 94) for a power project at Orchard Lake, at the head of Shrimp Bay, Revillagigedo Island, Alaska, and on the lands of the United States within the Tongass National Forest. The license is to extend for a period of fifty years, but the licensee is required to observe the following special conditions: Maintain records of stream flow and of the water held in and released from storage; to comply with such conditions as the Secretary of Agriculture shall deem necessary for the protection and utilization of the Tongass National Forest. No other use is to be made of the power, except in conjunction with the manufacture of pulp and paper, without the prior approval of the commission.

A license has been granted to James Hulme, W. E. McKinnen and Albert H. Piepenburg, representing an association of citizens of Pine Knot, Cal. (Project No. 227). The license covers a transmission line across public lands within the Angeles National Forest in San Bernardino County, California. The license was granted with the understanding that the construction of the transmission line must begin on or before Jan. 1, 1922, and be completed on or before Dec. 31, 1922.

The commission has amended the license granted recently to the Alabama Power Co. for its project at Duncan's Riffle so as to allow it to include lands near the dam-site from which stone is to be taken for use in building the dam and power house. Reasonable compensation must be made for the use of the land. The commission has rejected the application of Major R. L. Weeks, which covers this same project.

### Alaskan Permits Requested

Frank C. Dougherty, of San Francisco, has applied to the Federal Power Commission for a preliminary permit covering the development of a power project on Prince of Wales Island, Alaska. The plan involves the use of the waters of Karta River at the head of Karta Bay. It is planned also to use Salmon and Little Salmon Lakes for storage. It is estimated that 6,000 hp. will be generated. It is intended to use it in the manufacture of wood pulp.

Mr. Dougherty also has applied for a preliminary permit to cover power developments on Baranof Island, Alaska. One of these projects is at the Green Lake outlet at Silver Bay, where it is estimated that 6,500 hp. can be produced. Another power plant would be at Warm Spring Bay, on Baranof Lake. The applicant estimates that 6,500 hp. is available at that point. A third power site is at the Second Lake outlet at the head of Cascade Bay, where 7,000 hp. is estimated. The power development in both projects is to be used in the manufacture of wood pulp.

The commission recently voted that in the absence of its executive secretary his duties and authorities shall devolve upon its chief engineer.

Upon returning from his recent trip to England, Dr. George Otis Smith, Director of the Geological Survey, gave out a report on conditions in the coal-mining industry in England that is of especial interest at this time in view of the recent strike in that country.

Dr. Smith said that the public attitude toward the mine owners and coal dealers is much the same as in this country; there is a great surplus of coal on hand, but the public is waiting for prices to drop and buying as little as possible, in spite of repeated warnings that the inevitable rush of buying in the fall will send prices up rather than down. This condition followed closely the end of the strike, for, according to the report, "In six weeks after the mines were reopened supply had outstripped demand and miles of loaded coal cars were reported on sidings in both Scotland and England—cars of 'unwanted coal.'"

In discussing the system of wage payments agreed upon when the strike was settled, Dr. Smith said:

When fully effective, after the temporary period of readjustment, the terms of settlement provide for standard wages based upon former district rates and periodically adjusted in accordance with the proceeds of the industry as ascertained in such district. This is universal profit-sharing in a great nation's most important industry. Net profits are figured by coal mining districts, of which there are thirteen; 83 per cent of the surplus proceeds goes to increase wages and 17 per cent to capital. Several details of this scheme strike me as indicating enlightened economics, logical and helpful to clear thinking in this problem of fair division of responsibility and returns.

### Small Concerns May Be Exempt

In suggesting improvements in the gathering of industrial information by the Bureau of Census, the recently appointed committee, representing the industries, has suggested that no effort be made to collect statistics from establishments having an annual output of $5,000 or less. Heretofore the census has sought returns from every establishment having an annual output exceeding $500 in value. The committee discussed in detail the draft of the schedule proposed by Director Steuart, of the Census Bureau, for the 1921 census of manufactures. No public discussion of these schedules will be undertaken at this time.

Representatives of the industries, meeting with Commerce Department officials, emphasized the need of preventing duplication in Government questionnaires and statistics. Another important point made at the conference was the need for greater safeguards to prevent the disclosure and improper use of individual returns.

## Engineers to Co-Operate

A notable group of engineers from England, France and America is to gather for dinner at the Engineers Club in New York City on Oct. 10. The occasion will be in celebration of the home-coming of the delegation of American engineers that recently went to England and France to award the John Fritz medal to Sir Robert Hadfield, of London, and Eugene Schneider, of Paris, but greater significance will lie in the influence of the event upon the movement that is now on foot to promote good fellowship and co-operation among the engineers of the countries lately allied in the war.

This movement originated during the war and was a natural result of the necessarily close co-operation that existed between engineers of the different countries in carrying on their strenuous work in France. It is understood that the idea is meeting with hearty response from European engineers, and at the dinner in New York there will be present representatives of the principal engineering societies of Great Britain and France. The deputation of American engineers that awarded the medal will, of course, be among the guests at the dinner, as will also the members of the John Fritz Medal Board of Award, the Library Board of the Engineering Societies and of the Engineers Club, the trustees of the United Engineering Societies, the governing boards of the four national engineering societies and the officers of the Federated American Engineering Societies. A number of men of national prominence have been invited, including Herbert Hoover, Viscount Bryce and Charles E. Hughes.

## Cylinder Head Kills Two Men

Two men were instantly killed in the power plant of Wilson & Co., the Chicago packers, on the evening of Sept. 4, when the cylinder head of a 250-hp. engine blew out, hurling the men into the turning flywheel of another engine.

The men killed were the shift engineer and a fireman, and there were no other witnesses to the accident. Both men's skulls were fractured, both were scalded and one had almost every bone in his body broken. The condition of the bodies suggests that the one man was in the direct path of the cylinder head and met its full impact which carried him into the flywheel, while the other was blown into the flywheel by the pressure of the explosion. The engine had been operating continuously for more than a week and was presumably being shut down preparatory to being overhauled during Labor Day.

## Help for Inventors

An editorial in the Aug. 2 issue of *Power*, entitled "A Praiseworthy Effort To Help Inventors," told of the formation of an association that is to have for its purpose, on the one hand, the helping of obscure inventors to develop their ideas into commercially profitable ventures and, on the other hand, the protection of investors from loss through participation in alluring but impractical schemes. A number of letters have been received since the publication of this article, the writers of which have shown a keen interest in the new association and a desire to learn its name and address in order to get into touch with it. In view of the interest shown in the matter, *Power* has secured further information about the association mentioned. Its name, as given in the editorial, is Miller Reese Hutchinson, Inc., and its address is the Woolworth Bldg., New York City. In order that no one writing to this address may be disappointed, the requirements that must be met by prospective clients are given herewith.

In the first place, the invention should be patented before being submitted. If this is not done, there must at least be presented a sworn statement completely defining the extent of the idea. This, of course, is to obviate litigation later on. In the second place, the invention must be indorsed by "an engineer in good standing" as worthy of consideration. The broadest interpretation of this phrase is probably that it means a member of one of the national engineering societies. This requirement is to weed out propositions that have no merit. In the third place, the inventor is expected to bring his lawyer with him when offering his idea to the association, and if a satisfactory agreement can be reached, a comprehensive contract will be entered into by the association on the one hand and the inventor on the other.

From this time on the inventor will be given financial assistance if that is required, and finally, he will receive a percentage of the net profits resulting from the exploitation of the invention. This percentage will vary in different cases, but will not be likely to go as high as one-half; it will depend upon how well developed the idea is when it is turned over and how much the inventor himself can do in developing it further.

## Water Power in Foreign Lands

As indications of the interest being taken by foreign nations in hydro-electric development the following items, given out by the United States Bureau of Foreign and Domestic Commerce, are of interest:

For some time Mexican authorities have offered inducements for the establishment of hydro-electric plants in or near the Federal District, reports Assistant Trade Commissioner R. M. Connell, the plant of the existing power company being inadequate for the needs of the region. A decree has been issued reducing Federal taxes on the use of water for power and irrigation, and the press announces that two Mexicans have now submitted a proposal for the erection of such a plant.

The Imperial Railway Department of Japan is planning to construct a great hydro-electric plant at Niiagata Prefecture, using the water power of the Shinano River, states the *Far Eastern Review*. The plant will have a capacity of 84,000 kw. and will operate a section of 200 miles of line. It is expected that it will be in operation in 1926.

A report from Consul Carrigan, at Lyon, France, states that the legislation affecting the proposed combined hydro-electric, irrigation and navigation scheme for the River Rhone has been passed. The report goes on to state that this is simply the putting into legal form of the general plan embracing the principles of the project, and the outlining of a scheme of organization, leaving the details to be handled by concessioners.

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According to an announcement of the Public Service Commission of New York, the New York Steam Co., which went into the hands of a receiver in 1918, has been taken over by the New York Steam Corporation. The new company is authorized to issue 20,000 shares of common stock (no par value), mortgages for $400,000 on its real estate and 8 per cent general mortgage bonds to the amount of $2,300,000. The new board comprises: President, Joseph D. Hurst (formerly assistant secretary, Guaranty Trust Co.); secretary, George F. Hubbell, Jr.; Fred Pope, A. R. Gortrelle, A. F. Hurd, A. C. St. John, Philip Russell.

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## Personals

**Ellwood Rowand, Jr.**, is now with the Northern Indiana Gas and Electric Company, Hammond, Ind.

**Peter Ehlers** has resigned his position as chief engineer for the McCahan Sugar Refining Co., of Philadelphia, Pa.

**George H. Krueger**, formerly with the Anderson Draft Regulator Company, is now mechanical engineer in Seattle, Wash.

**James A. Brakes, Jr.**, has left his position as head of the department of mechanical engineering at Ohio Northern University, Ada, Ohio, and is now structural engineer for the Chateaugay Ore and Iron Co., Lyon Mountain, N. Y.

**R. W. Callaway** has resigned after a short term of service as superintendent of the municipal gas, water and light plant at Augusta, Kan., and has accepted his old position as superintendent of the Newkirk, Okla., plant which he had formerly held for three years.

## Society Affairs

**Metropolitan Section**, A. S. M. E., will hold its first meeting of the season Sept. 23, in Engineering Societies Building, New York City. "Snow Problems in Cities" will be discussed.

**Metropolitan Section**, American Welding Society, will hear a lecture by E. Wanamaker, E.E., of the Chicago, Rock Island & Pacific R.R., on "Practical Applications of the Electric Arc Welding Process" on Sept. 20.

**Detroit Section**, A. S. M. E., will hold a joint meeting Sept. 16 with the technical societies of Detroit. John C. Parker will speak on the proposed affiliation of all the technical societies in Detroit and will present a draft of the constitution proposed for the new organization.

## Business Items

**Montgomery & Fishkin**, New York City, a firm of mechanical and structural engineers, has been organized by Graham L. Montgomery, who is also a partner in the industrial engineering firm of Vreeland Fishkin & Co.

**The Canadian Planet Engineering Co.**, Auditorium Block, Windsor, Ont., has acquired a charter to manufacture and sell in Canada the "Planet" soot blower. The device is now being manufactured and sold in this country by the Marion Machine Foundry and Supply Co., Marion, Ind.

**The Ferguson-Herbert Corporation** has been formed by combining the casting and manufacturing facilities of John Ferguson's Foxhill Foundry and the sales and engineering organization headed by Frederick D Herbert, the New York manager of the marine department of the Terry Steam Turbine Co. The object of the new corporation will be to fill the need for engineering supervision of material. Among its products will be boiler tubes.

## Trade Catalogs

**The Nash Engineering Co.**, South Norwalk, Conn., is distributing two new bulletins, No. 16 and 17, attractively illustrated in colors, describing "Hytor" air line vacuum heating and condensation pumps.

**Pierce, Butler & Pierce Manufacturing Corp.**, 437 East 162d St., New York City, is sending out a 32-page booklet, "Pierce Packless Valves." These valves are designed to obviate the necessity of renewing the packing and are made in many different styles and sizes.

**The Texas Co.**, 17 Battery Place, New York City, has prepared a 6 x 8-in. 36-page booklet called "Lubrication of the Steam Turbine," which contains many useful operating pointers on lubrication. It is practical rather than theoretical and contains very little advertising matter.

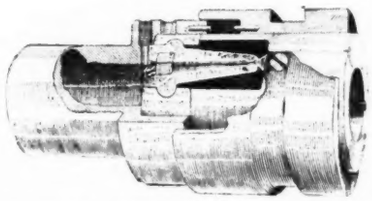
# Condensed-Clipping Index of Equipment

*Patented Aug. 20, 1918*

**Clutch, Positive Locking Friction**

Carlyle Johnson Machine Co., Manchester, Conn.

"Power," July 19, 1921

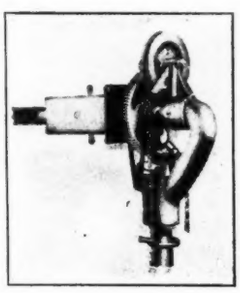


The clutch body is fastened to the shaft and carries a split ring in which are inserted a pair of toggle levers. A curved wedge, made part of a sliding shifter sleeve, forces the levers apart, expands the ring and brings its outer surface into frictional contact with the inner surface of the friction cap. One screw which moves two taper blocks, set into the levers, adjusts the contact of the ring and cap to any tension. A positive locking arrangement is also incorporated, consisting of six pairs of opposing pins spaced at equal distances on the shoulder of the shifter sleeve and on the edge of the friction cap. With the clutch in the running position, the pins are engaged and slippage is prevented.

**Blower, Valv-In-Head Soot**

Diamond Power Specialty Co., Detroit, Mich.

"Power," Aug. 2, 1921

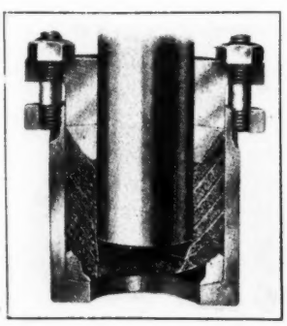


The main feature of this soot blower is a poppet valve that controls the individual unit as an integral part of the head. The valve is held to its seat by a spring and is forced from its seat by a steel cam, operated by a revolving sheave wheel, pulled by a hand chain. The sheave-wheel pinion meshes with a gear that carries the cam. As the sheave wheel is revolved, the cam causes a lever to press down on the valve stem, thus opening the valve. After the gear has been further rotated, the cam releases the lever and allows the steam pressure to close the valve. A vacuum breaker prevents the suction of gas in the blower element when steam is off and also acts as a whistle, which sounds while steam is on.

**Packing, Q-P Self-Setting**

Q P Signal Co., Needham Heights, Mass.

"Power," 1921.

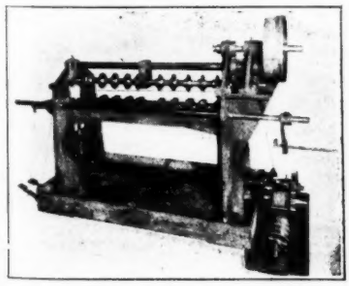


This self-setting packing consists of a series of conical fibrous rings set loosely in the stuffing box. The lips of the rings automatically respond to the pressure from the cylinder, holding it at any pressure with sufficient force to prevent leakage. It is made of cotton and rubber for hydraulic service, cotton, rubber and lead for ammonia, and asbestos for steam, fuel oil and compressed air.

**Machine, Multi-tube Cutting-off**

Nathan F. Fretter, 9113 Columbus Ave., Cleveland, Ohio.

"Power," 1921

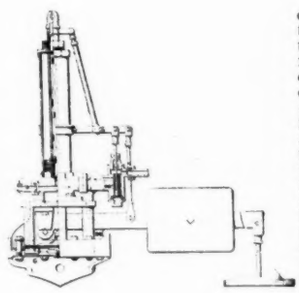


This machine will cut pipe or tubing in a number of pieces in one operation. A number of rotary cutters are mounted and adjustable on the shaft, driven through back gearing and a driving pulley. The table has a dovetail groove, in which slide tube rests or holders which are adjustable to correspond with the cutters. The table is adjusted to suit different diameter tubes and wear of cutter. The cutters can be readily removed and are sharpened by using a grinder while they rotate on a machine. This machine has a large capacity according to the number of cutters used and will cut 2½ outside diameter tube with ⅜-in. thick wall.

**Regulator, Victor High-Pressure Damper**

Atlas Valve Co., 282 South St., Newark, N. J.

"Power," July 26, 1921

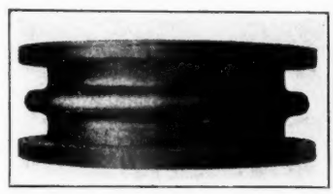


This regulator is operated hydraulically, the water passing to the plunger cylinder being controlled by a pilot valve which forces the piston in the large cylinder either up or down, according to the pressure of steam on a diaphragm. The regulator is equipped with a compensating attachment which acts as an intermediary medium to counteract the movement transmitted to the pilot valve by the steam pressure under the diaphragm, which balances the position of the damper, or on intermediate pressure changes, and permits the damper to be fully opened or closed only on extreme boiler-pressure variation.

**Joint, Low-Pressure Expansion**

The Griscom Russell Co., 90 West St., New York.

"Power," 1921.

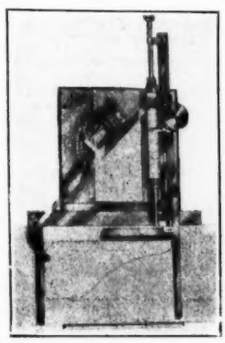


The flanges of this joint are of cast iron and the expansion metal is of copper, having a single corrugation, the sides of which are parallel for at least one inch of their length. The method of manufacture permits the use of thinner sheet, increases flexibility of the joints and eliminates thinned spots. The joint is guaranteed to compress ¼ in. axially when subject to a compressive force of 125 lb. per inch nominal diameter, and to be capable of distortion laterally ¾ in. with a force of 125 lb. per inch nominal diameter. These joints are of the low-pressure type and are designed particularly for use between the turbine and the condenser.

**Planimeter, Bushnell-Coffin Improved**

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

"Power," 1921.

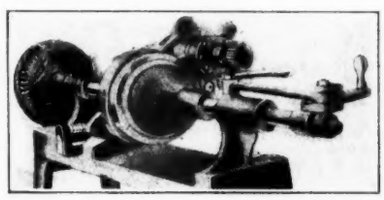


This instrument is provided with a revolving scale drum containing six scales most commonly used in reading the mean effective pressure from engine indicator diagrams. This scale drum is removable, and it may be changed for other drums containing different scales, thus eliminating the necessity of having a large number of scales. The area of the diagram is read from the vernier and wheel, and the mean effective pressure is read directly on the revolving scale.

**Cleaner, Paragon Boiler Cap**

The Paragon Power Specialty Co., Hartford, Conn.

"Power," 1921.



The work of cleaning the caps, both round or oval-shaped, of inside-cap water-tube boilers can be done by a machine designed for this purpose in a much shorter time than they could possibly be done by hand. A mainshaft turns the cap and a turreted tool holder carries a rocking device. The tool holder is equipped with a scalping or stripping tool which removes the gasket, after which a wire brush cleans the fiber and scale from the surfaces. Very hard incrustations are removed with a toothed cutter of the emery-wheel dresser type. The machine is geared to reduce the speed of turning the cap. No special knowledge is required to operate it.

*Clip, paste on 3 x 5-in. cards and file as desired*

## FUEL PRICES

### BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

| Coal | Market Quoting | Aug. 30, 1921 | Sept. 6, 1921 |
|---|---|---|---|
| Pool 1, | New York | $3.25 | $3.00@3.50 |
| Pocahontas, | Columbus | 3.15 | 3.00@3.25 |
| Clearfield, | Boston | 1.80 | 1.65@2.20 |
| Somerset, | Boston | 1.70 | 1.45@2.00 |
| Pittsburgh, | Pittsburgh | 2.25 | 2.00@2.30 |
| Kanawha, | Columbus | 2.15 | 2.00@2.25 |
| Hocking, | Columbus | 2.15 | 2.00@2.30 |
| Pittsburgh No. 8 | Cleveland | 2.30 | 2.25@2.35 |
| Franklin, Ill., | Chicago | 2.90 | 2.40@3.50 |
| Central, Ill., | Chicago | 2.40 | 2.00@2.75 |
| Ind. 4th Vein, | Chicago | 2.50 | 2.35@2.75 |
| Standard, | St. Louis | 1.85 | 1.75@1.90 |
| West Ky., | Louisville | 2.45 | 2.25@2.40 |
| Big Seam, | Birmingham | 2.10 | 2.00@2.25 |
| S. E. Ky., | Louisville | 2.30 | 2.25@2.40 |

**New York**—On Sept. 7, Port Arthur light oil, 22@25 deg. Baumé, 4½c. per gal. 30@35 deg., 5½c. per gal. f.o.b. Bayonne, N. J.

**Chicago**—Aug. 27, for 24@28 deg. Baumé, 40@45c. per bbl.; 32@34 deg. 1¼@1½c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

**Pittsburgh**—On Aug. 29, f.o.b. refinery; Pennsylvania, 36@40 deg., 3½ to 4c. Oklahoma, 24@30 deg., 45@50c. per bbl.; gas oil, 32@34 deg., 1¾c. per gal., 36@38 deg., 1¾c. 38@40 deg., 1⅞c.

**St. Louis**—Sept. 3, prices f.o.b. cars, tank lots: 24@26 deg. Baumé, 45c. per bbl.; 26@28c. deg., 55c.; 28@30 deg., 60c.; 32@34 deg. 1¼c. per gal.

**Philadelphia**—On Sept. 6, 26@28 deg. Baumé, Oklahoma, 50c. per bbl.; 30@34 deg., Oklahoma (group 3) 75c. per bbl.; 16@20 deg. Seaboard, 3¼c. per gal.

**Cincinnati**—Aug. 31, for 22@28 deg. Baumé, 3c.; Diesel, 26@30 deg., 2¼c. per gal.

**Cleveland**—Aug. 31, for 22@28 deg. Baumé, 5c. per gal.

## New Construction

### PROPOSED WORK

**Me., Washburn**—The Aroostook Valley Railroad Co., A. R. Gould, Pres., Presque Isle, is having plans prepared for 111 miles railway through Northern Maine to Frenier Lake, Quebec, Can., to be known as the Quebec extension. Cost, including electrical equipment, $6,000,000. Private plans.

**N. Y., Cortland**—The Valeria Home, 7 East 42d St., New York City, will receive bids until about Sept. 15 for an institution here. About $1,000,000. Delano & Aldrich and C. H. Higgins, 19 West 44th St., New York City, Archts. Noted Jan. 11.

**N. Y., Syracuse**—The city received bids for heating and ventilating system for Franklin School, N. Avon St., from Ryan Plumbing & Heating Co., 160 Court St., Watertown, $63,280, W. B. Goldie, 274 James St., Syracuse, $69,381, and E. Joy & Co., 133 Market St., $68,500.

**N. J., Jersey City**—The Y. M. C. A., S. M. Lipscomb, Secy., 72 Montgomery St., is having sketches made for a Y. M. C. A. building on Bergen Ave. About $500,000. J. F. Jackson, Gotham Natl. Bank Bldg., Columbus Circle, New York City, Archt. and Engr.

**Ala., Birmingham**—The County Coal Co., c/o Capt. Neeny, 2120 2nd Ave., is in the market for one 150 hp. horizontal boiler and one 15-20 hp., 500 r.p.m., D. C., 3 phase electric motor (new or used).

**Ala., Birmingham**—The Morse-McCormick Coal Co., C. B. Morse, American Trust Bank Bldg., is in the market for one 150 hp. upright boiler (new or used).

**Miss., Greenwood**—The city plans an election to vote $55,000 in bonds for the construction of storm sewers and purchasing pumps.

**La., New Orleans**—The Washington Ice Co., 611 Louisiana Ave., D. Grffagnino, Pres., plans to build a plant on Cadiz and Greret Sts. Cost between $125,000 and $150,000. Internal combustion engines, modern draw water ice plant and other machinery for artificial ice making will be installed.

**Tenn., Newport**—W. A. Nelson is in the market for complete equipment and machinery for 10 to 15 ton ice plant.

**Ind., Lafayette**—Student Union, 24 Russell St. W., plan to construct a 3 story, dormitory and school building, including a steam heating system. About $500,000. Pond & Pond, 64 West Van Buren St., Chicago, Ill., Archts.

**Mich., Detroit** — The Bd. Educ., 1354 Bway. Ave., received bids for a 3 story, 82 x 246 ft. and 113 x 130 ft. school building including a steam heating system on Brooklyn Ave. from O. Misch Co., 36 State St., $380,379. M. A. Mahoney, 400 Penobscot Bldg., Detroit, $398,700 and H. G. Christman Co., 315 Stevens Bldg., Detroit, $408,268. Noted Aug. 2.

**Mich., Plymouth**—The Detroit House of Correction, J. O. Stutsman, Supt., 1441 Alfred St., plans to construct several buildings including a separate steam heating plant for a penal institution near here. About $3,000,000. A. Kahn, 1000 Marquette Bldg., Archt.

**Ill., Litchfield**—The city is having plans prepared for a pumping station, filter plant and dam. About $175,000. Pearse, Greeley and Hansen, 39 West Adams St., Engrs.

**Ill., Mt. Carmel**—The county c/o G. C. Harvey, Engr., Court House, is having plans prepared for 13 mi. drainage ditches Dist 6 and 7 and pumping stations. About $200,000.

**Wis., Cudahy**—The School Bd. plans to build a 3 story high school. Cost between $200,000 and $300,000. F. H. Williamson, Pres. Architect not selected.

**Wis., Jefferson** — The Lake Mills Condensed Milk Co., C. A. Baumann, Pres., is in the market for boilers.

**Wis., Kiel**—The Kiel Woodenware Co. is receiving bids for a 250 kw. generating unit and switchboard. Cahill & Douglas, 217 West Water St., Milwaukee, Engrs. Noted Aug. 9.

**Wis., Rice Lake**—The Brunett Htg. Co., c/o D. A. Brunett, Pres., Minneapolis, is having plans prepared for a 5 story, 60 x 150 ft. factory. About $500,000. E. Craite, Rice Lake, Vice-Pres., in charge. Private plans.

**Wis., Sheboygan** — The East Wisconsin Electric Co., c/o H. Ellis, V. Pres., is receiving bids for a 60 x 210 ft. generating plant on Main St. About $350,000. Bids will be taken later on machinery and equipment. Private plans.

**Ia., Davenport**—The Davenport Ice Co., 1st and Myrtle Sts., plans to build a 2 story ice plant. About $75,000. Architect not selected.

**Minn., Cloquet**—The city is having plans prepared for deep well, electric pump station and water main. About $25,000. J. Wilson, First Natl. Bank Bldg., Duluth, Engr.

**Kan., Leavenworth**—The U. S. Government, Washington, D. C., is having plans prepared for a power plant at the Federal Penitentiary, here. About $30,000. Also purchase and installing engines and boilers. About $115,000. W. I. Biddle, Warden.

**Mo., Clinton**—The city, c/o R. Lobaugh, Mayor, plans to build an addition to electric light plant. About $35,000. J. Pearcey, Engr.

**Mo., St. Louis** — The Standard Underground Cable Co., Westinghouse Bldg., Pittsburgh, Pa., is having plans prepared for a 2 story, 300 x 525 ft. manufacturing plant on Kingshighway and Slevin Ave. About $1,000,000. Widmer Eng. Co., Syndicate Trust Bldg., Archt. Noted June 7.

**Mo., St. Louis**—The St. Louis Lead & Oil Co., International Life Bldg., will receive bids until Sept. 15 for an 18 x 22 ft. and 27 x 47 ft. power plant on Manchester and Sublette Aves. About $25,000. Private plans.

**Ont., Cochrane**—Hollinger Consolidated Mines, Ltd., Timmins, is having surveys made for a hydro-electric power development at Long Saulte Rapids and Kettle Falls on the Abitibi River, about twenty miles northwest of here. About $2,000,000.

### CONTRACTS AWARDED

**Me., West Pownal**—The State Feeble Minded Comn. has awarded the contract for a 1 story, 45 x 73 ft. central heating plant at state school here to H. P. Cummings Constr. Co. Fidelity Bldg., Portland. About $70,000. Noted Aug. 2.

**Mass., Cambridge**—A. F. Robinson, Commercial Ave., has awarded the contract for a 1 and 2 story, 95 x 195 ft. addition to boiler shop on Binney and 2d Sts., to Joslin & Landry Co., 161 Devon St., Boston. About $70,000. Private plans.

**Conn., Hartford** — The Orient Insurance Co., 20 Trinity St., has awarded the contract for a 5 story, 48 x 98 ft. addition to office building on Clinton St. to M. Eidlitz & Sons Co., 30 East 42d St., New York City. About $350,000. A steam heating system will be installed.

**Conn., Waterbury** — The Leavenworth Co., Leavenworth St., has awarded the contract for a 2 story, 90 x 105 ft. bank building on Leavenworth St. and Kendrick Ave. to Tracy Bros. Co., 52 Benedict St. About $300,000. A steam heating system will be installed.

**N. Y., New York**—S. B. Steinmetz, 449 East 149th St., will build a 2 story, 100 x 200 ft. theater on Webster Ave. and 169th St. About $250,000. Private plans Owner will build by day labor.

**N. Y., New York**—The 610 West 110th St., Corp., 2458 Grand Ave., L. Gerbino, Pres., will build a 14 story, 100 x 100 ft. apartment on Cathedral Pkway. near Bway. About $1,000,000. Private plans.

**Mich., Detroit**—Alvord & Burdick, Engrs., 8 South Dearborn St., Chicago, Ill., have awarded the contract for a sewer and pumping station to J. J. Bacco, Detroit. $85,351.

**Mich., Ironwood**—City let contract constructing a 2 story, 137 x 161 ft. municipal memorial building to Albinson Constr. Co., 300 5th Ave., S. Minneapolis. $263,230. A steam heating system will be installed.

**Mich., Saginaw**—The Saginaw Genl. Hospital Assn., c/o J. W. Johnson, Secy., Bearinger Bldg., has awarded the contract for a 4 and 5 story, 50 x 90 ft. hospital to O. W. Jankins Constr. Co., 223 South Washington St. About $600,000. A high pressure steam heating system will be installed.

**Mich., Saginaw** — The West Side Bd. Educ., C. A. Kuehn, Secy., has awarded the contract for a 3 story, 115 x 125 ft. school to Spence Bros., Brewer Bldg., $700,000. A steam heating system will be installed.

**Ill., Chicago**—M. Born & Co., 540 South Wells St., has awarded the contract for a 12 story, 45 x 120 ft. clothing factory at 700-10 West Harrison St. to R. F. Wilson & Co., 1851 Elston Ave., $750,000. A steam heating system will be installed.

**Ill., Chicago** — C. Henneberry Co., 455 East 22d St., let contract building 6 story, 100 x 221 ft., printing plant, at 2242-54 Cottage Grove Ave., to McLennan Constr. Co., 3105 South Calumet St. About $750,000. A high pressure steam heating system will be installed.

**Ill., Chicago** — Plotke & Grosby, 2532 North Clark St., have awarded the contract for two 3 story, 109 x 143 ft. apartments, one on Brompton and Pine Grove Aves. and one on Cornelia and Pine Grove Aves. to the Barrett Constr. Co., 77 East Washington St., $300,000 each. Steam heating systems will be installed. Noted April 26.

**Ill., Chicago** — The Woodlawn Battery Co., 1466 East 67th St., has awarded the contract for a 1 story, 50 x 125 ft. battery service station at 1540 East 67th St. to G. A. Gungall, 6407 South Park Ave., $40,000.

**Ill., Lawrenceville**—The Lawrenceville Cooperage Co., c/o St. Louis Cooperage Co., H. Meyer, Pres., St. Louis, Mo., has awarded the contract for a 1 story, 24 x 48 ft. power plant, also storage and cooperage buildings, to the Austin Co., 208 South La Salle St., Chicago. About $50,000.

**Wis., Prairie du Sac** — The Wisconsin River Power Co., has awarded the contract for a 1 story, 60 x 81 ft. power and machine shop on Main St., to Dresen Bros. Co. About $50,000.

**Minn., Bemidji** — The Bd. Educ. has awarded the contract for a 2 story, 148 x 230 ft. high school on 1st Ave. to E. Jackson, $240,200. A steam heating and ventilating system will be installed.

**Minn., Sleepy Eye**—The city has awarded the contract for furnishing and installing one Nordberg-Todd engine and one Allis Chalmers generator 350 KVA to J. G. Robertson, 2542 University Ave., St. Paul. About $18,000. Noted Aug. 23.

**N. D., Dickinson**—The Bd. of Administration, Bismark, Chas. Liessman, Secy., has awarded the contract for a power plant at the Normal School here, to Harrison & Son, Jameston. About $40,000. Noted Aug. 2.

**Que., Montreal**—The city has awarded the contract for a 130 x 212 ft. pumping station to Allas Constr. Co., 37 Belmont St., $498,800.

**Que., Montreal**—The McGill College, Sherbrook St., has awarded the contract for a 6 story, 65 x 72 x 175 ft. medical building on Milton St. to E. G. M. Cape & Co., 10 Cathcart St. Cost between $350,000 to $400,000